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CARRIAGE BRIDGE OVER THE PENNSYLVANIA RAILROAD.

We present with the present issue an engraving of the carriage bridge constructed last year over the Pennsylvania Railroad at Fortieth street, Philadelphia, from designs furnished by Mr. Joseph M. Wilson, of the firm of Wilson Brothers & Co., civil engineers and architects, Philadelphia, and who is also Engineer of Bridges and Buildings of the Pennsylvania Railroad Company. This bridge, the engraving of which will no doubt recall to the recollection of all the Centennial visitors its general features, is designed on what is called abroad the Ordish stiffened suspension pian, the principles of which were, however, developed and published in this country as long ago as 1847 by a well known American engineer, Mr. S. Whipple, to whom must be given due credit.

The bridge is in three spans, a center span of 189 feet and two side spans of 69 feet 6 inches each, making a total of 328 feet. It has two trusses with outside sidewalks, the total width being 60 feet, giving a carriage way of 40 feet and two footwalks of 10 feet each. The towers are of wrought iron, covered with an ornamental finish of cast and galvanized iron. The suspension cables are of wrought iron upset weldless links with pin connections. The main compression and stiffening member is of boiler plate, from which are suspended at intervals the wrought iron built cross girders supporting the longitudinal timber floor joist of the roadway and sidewalks. The roadway and sidewalks are covered with a sub-flooring of two inch white pine plank, the former having on top a three inch layer of white oak, and the latter a tongued and grooved flooring of one and a half inch yellow pine planed on the upper surface.

The bridge is on a skew of 62° 35′ 47″ to the left.

The anchorages in the abutments resist only the vertical pull from the cables, the horizontal pull being taken on to a compression member forming the lower chord of the boiler plate stiffening girder. The bridge, with the exception of some strictly ornamental work, is constructed entirely of wrought iron, and finished in a highly artistic and ornamental style well suited to its prominent location in a large city.—*Railroad Gazette.*

ELECTRICAL CAR SIGNAL.

It is impossible to bring the English mind down to an appreciation of the simple bell cord used on all American railway trains, and our British cousins have invented a great variety of substitutes. Here is the last:

A system of train communication, invented and patented by Mr. Stroudley and Mr. Russbridge, was lately tested on the London and Brighton Railway. The communication from the passengers is made by pulling out a small button fitted into a case fixed to one side of the carriage, which causes a bell to ring on the engine and in the guard's van. This bell continues ringing until the button is replaced, which can only be done by a person having the proper key. Hitherto, objections to the introduction of electricity as a means of communication have been raised on the grounds that in trains that were liable to be frequently broken up, there would be great difficulty in making the connection between the carriages quickly and surely. This objection has been overcome in a very simple and ingenious manner. To the end of each carriage, attached to the wire connecting the batteries at each end of the train, is a connecting coupling, composed of a wire coil covered with india rubber, terminating in a simple but safe catch, which fits into the coupling of the next carriage. These are placed at such a height from the ground that the porter who is uncoupling any carriage can conveniently perform the same operation as regards the communication. By the aid of a Bell code the guard and driver can send simple messages to each other. The apparatus has been working very satisfactorily for some time, and is to be adopted all over the London and Brighton Railway system.

THE YIELD OF FLOUR PER HORSE-POWER.

We extract the subjoined from an article in the *Miller and Millwright* by H. F. Weller:

Oliver Evans, who wrote on milling subjects during the first quarter of this century, says that his observations have shown that in mills run by a water-power equal to eight horse-power, a stone 1·5 meters in diameter (a meter is about 39·37 inches) ground per hour, 1·1288 hectolitre (a litre being equal to about 2·75 bushels). This gives an average of ·1411 hectolitres, or 14·11 litres to each horse-power. Evans, further on, says that millstones of 1·9 meters grind 1·8133 hectolitres per hour.

Later statisticians have made the following observations:

In a water-power mill at Rochester, N, Y., which had sixteen pairs of stones, each having a diameter of 1·45 meters, the amount ground by each pair in twenty-four hours was 49·44 hectolitres of superfine flour. In a mill at Richmond, Va., with eight pairs of stones, each 2·1 meters in diameter, the amount was 51¼ hectolitres to each pair in twenty-four hours. These two items give an average of a little over two hectolitres per hour for each pair. Counting five horse-power to each, the average is 40·96 litres. We here see the tremendous differences that exist in different statistics, Evans' average being 14·11 litres, and other authorities going as high as 40·96 litres. Evans' observations, however, were made before 1820 (his published works bears the date of 1826, which was after his death), while the other experiments were made recently.

ENGLAND.

Farcy estimates that, in English mills, each horse-power grinds about 33⅕ litres of wheat per hour. Fairbairn, in his "Treatise on Mills and Mill Works" (London, 1863), adopts about the some figure. Fairbairn speaks of a large English mill, which he erected in Russia, that is run by two steam engines, each of 100 horse-power. This mill yields 69·0257 hectolitres of flour per hour. Dividing this by 200, it gives ·345 hectolitres, or 34·5 litres, per hour for each horse-power.

The Royal Mills, at Plymouth, erected in 1833, are run by two steam engines of forty-five horse-power each, and have twelve pairs of stones, each stone being 1·25 meters in diameter, and making 123 revolutions per minute. The statistics gathered here show a yield of 43·584 hectolitres per hour, which, divided by 90 horse-power, gives 48 litres per hour to each horse-power. Besides grinding this flour or meal, the engines run eight bolting machines and four smut machines.

Maudsley, a London millwright, gives the yield of mills erected by him at 41·25 litres per hour to each horse-power.

FRANCE.

It is claimed in France that the mills there are compelled to give finer flour than is necessary elsewhere. This is said to be the reason why French mills, compared with prominent American and English mills, show a small yield, ranging from 27 litres to 37 litres per hour for each horse-power. The renowned Darblay Mills, at St. Maur, whose flour has a world-wide reputation, uses stones 1·3 meters (about 4¼ feet). A recently erected mill, at Nantes, of six runs, is said to use stones of 1·25 meters, and a steam engine of only twenty horse-power. This statement, however, has been called into question, for it must be considered that this engine is compelled not only to furnish the power for the stones, but also to supply the power for all the other machinery in the mill.

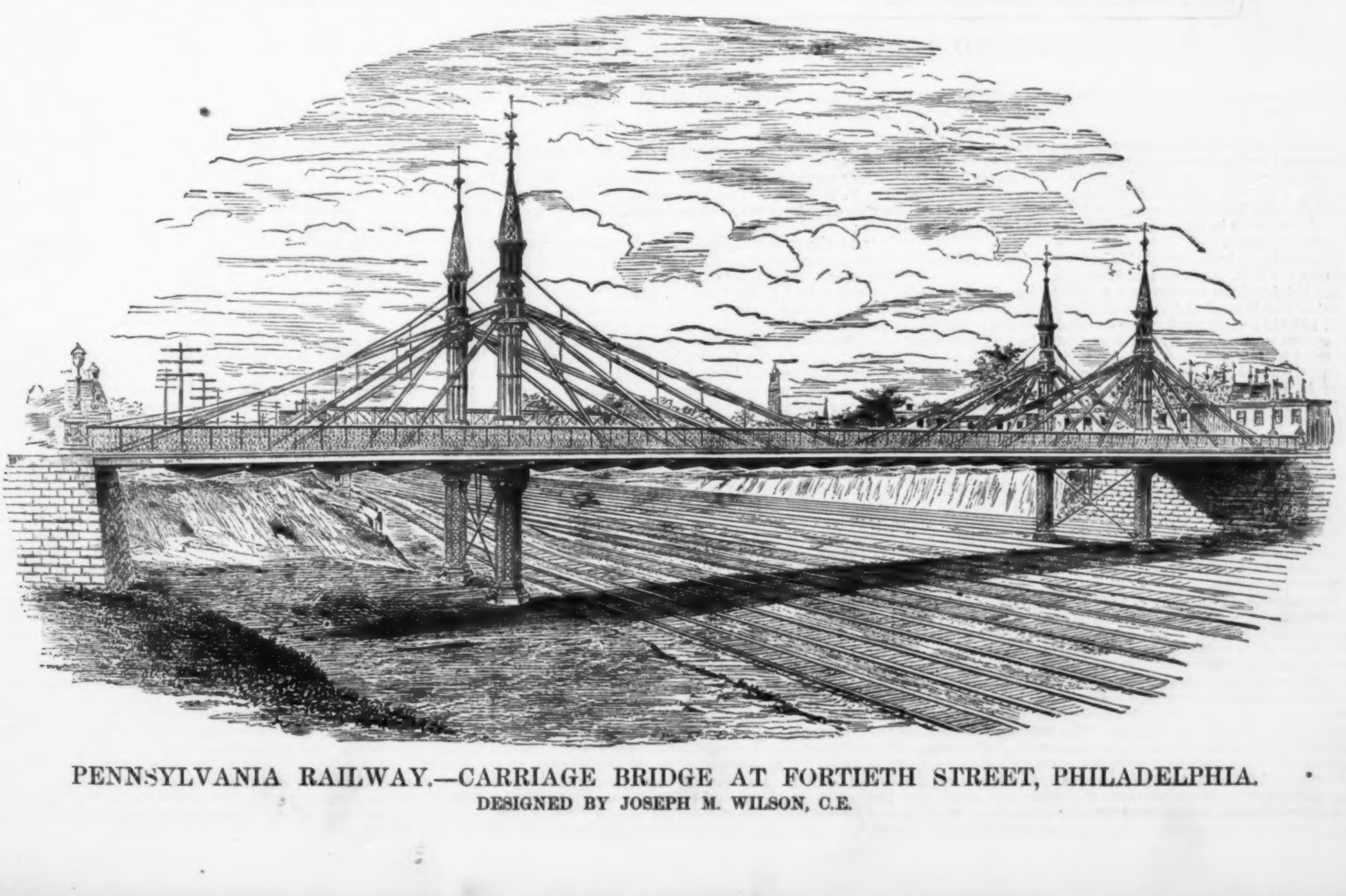
There are but few statistics of the amount of grain ground in French mills, and all statements must be taken for what they are worth. Viollet claims that a pair of millstones which is supplied with three horse-power will yield one hectolitre of flour per hour, or 33⅓ litres to each horse-power. The reason why *three* horse-power is taken is that, in France, a pair of stones is supposed to need three horse-power, besides the power required for bolting chests and other machines, which latter will require one more horse-power to each pair. This supposition cannot, however, be relied upon.

Benoit, author of the "Guide de Meunier," puts a rather different estimate on record. According to his account, the steam mill at St. Denis, which uses stones of 1·25 meters, and has six pairs, yields in twenty-four hours about 180 pounds. The engine is one of twenty horse-power, and runs all the machinery of the mill. Besides these steam engines, the St. Denis mill has four pairs supplied with water power equal to eight horse-power, each stone having a diameter of 1·75 meters. The mill grinds, in twenty hours, 52·2 hectolitres, which averages 2·175 hectolitres (217·5 litres) per hour, or 27·2 litres to each horse-power.

GERMANY AND HUNGARY.

One mill in Prague, whose millstones measure only 2¾ feet in diameter, and make 238 revolutions per minute, has a water-wheel furnishing eight horse-power. Experiments in this mill indicates that each horse-power averages only 10·25 litres per hour.

Ruhlmann, a prominent member of the Society of German Millers, in a recently published book on mechanics, says that a mill at Soest, in Westphalia, yields per hour 24·25 litres to each horse-power. German millers seem to accept 27·5 litres per hour to each horse-power as a good average.



PENNSYLVANIA RAILWAY.—CARRIAGE BRIDGE AT FORTIETH STREET, PHILADELPHIA.
DESIGNED BY JOSEPH M. WILSON, C.E.

THE PARIS EXHIBITION OF 1878.

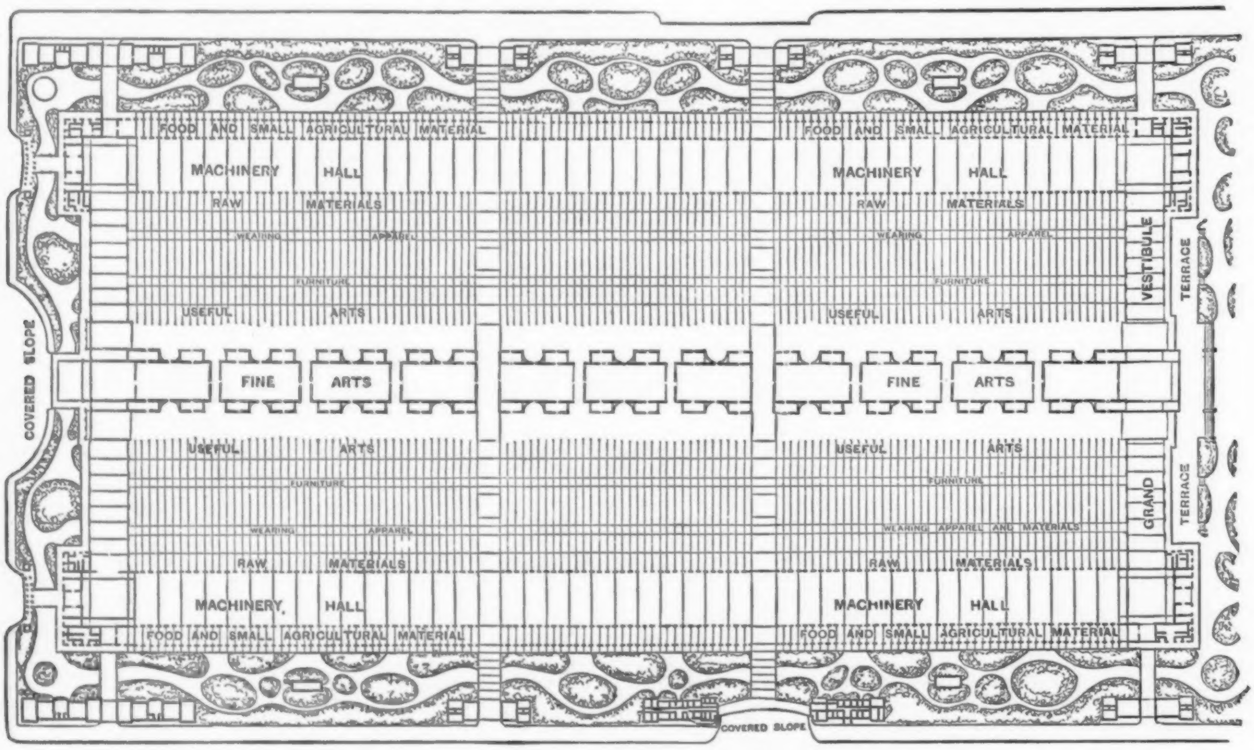
The building will, as in 1867, be erected in the Champ de Mars, and will cover its entire extent, reaching from the Ecole Militaire to the river Seine, at the bridge of Jena. Several subsidiary buildings and offices will be erected in the gardens of the Trocadero; and a grand central hall for *fêtes*, ceremonial occasions, etc., will stand in the middle of the further end, on the higher ground towards the Bois de Boulogne. Two crescent-shaped side structures of great extent will be devoted to the historical collections of pictures, contemporary paintings being exhibited elsewhere. The fountain and cascade will be very attractive features. The cascade will be 160 ft. wide, falling in several descents to a lake, from which the different parks and shrubberies will be watered. The palace of the Trocadero is from one pavilion to the other about 1,330 ft. in length, the pavilion at the extremities being connected with the great central rotunda, from the foot of which will flow the cascade, by galleries forming segments of a semicircle. In the great hall of the rotunda an immense organ is to be placed, and concerts will be given on the grandest scale. It will have a large parterre, two rows of boxes, and above all an amphitheatre, and will seat 8,000 people. Round the concert room outside, giving access to the boxes, are to be double galleries, closed from the weather, and affording to promenaders a splendid view of the city. On either side are to be peristyles opening on the Place du Trocadero on the side of the Bois du Boulogne. Above them are the offices of the managers and committees; they also serve as vestibules to the two great curved galleries that run from the central rotunda to the pavilion. These galleries are in a succession of halls; before each is a light covered portico, running the whole length.

From all parts of Paris will be visible the two immense towers, 260 ft. in height, flanking the Trocadero. A flight of seventeen broad steps conducts to the palace, before the portico of which a wide terrace will stretch from one extremity to the other. The principal entrance is to be at the middle, and at each end will be two immense domes in iron and glass, surmounted by lanterns and flagstaffs. The gardens stretch out on either side of the façade between the palace and the avenues, and will contain a number of small buildings, kiosks, model farms, cottages, *cafés*, greenhouses, and the like. The centre is left unoccupied for the better convenience of spectators.

The architects in charge of this important feature of the exposition are MM. Davioud and Bourdais.

The height of the new structure may be imagined when it is stated that of the grand vestibule will be 82 ft. In 1867, 179,010 square yards were covered; but next year 280,-800 square yards, or nearly 37 acres, will be under cover of the great building.

The structure will be bounded by the Trocadero—to the right in our plan—the Avenue de Suffren—at the top—and the Avenue de la Bourdonnaye—at the bottom in our plan—while the end opposite the Trocadero will face the Avenue de la Motte Piquet.—*Engineer.*



GROUND PLAN OF THE PARIS EXHIBITION BUILDING, 1878.

PARIS UNIVERSAL EXHIBITION OF 1878.

REGULATIONS FOR EXHIBITORS.

The French Commission for the Universal Exhibition, to be held at Paris in 1878, have just issued a brief summary of the principal regulations specially affecting foreign exhibitors, which are as follows:

The exhibition will open on May 1, 1878, and will close on October 31, 1878. Goods will be admitted to the exhibition from January 1, 1878, to March 30, 1878, both days inclusive. Objects of great value may, by special arrangement, be received later than March 30. Goods must be in their places and all arrangements completed by April 15. There will be no duties to pay on any goods except those intended for consumption. All objects exhibited will be protected against piracy of inventions or designs. The General Commission will take precautions for the safe preservation of all objects in the exhibition, but will not be liable for loss or damage of any kind. There will be no charge for flooring, except in the machinery gallery. A limited quantity of steam, gas, and motive power will be supplied free of charge. The placing of heavy objects requiring special foundations or adjustment may, by special arrangement, begin at an earlier period than January 1. Exhibitors are free to insure their goods. All costs of packing, transport, placing and care of goods, storage of empty cases, and the like, are to be borne by exhibitors. Noxious and explosive substances will be prohibited as usual. All goods will be exhibited under the name of the person who has signed the application for admission. No article may be withdrawn before the close of the exhibition without the special consent of the General Commissioner. All goods must, under penalties, be removed before December 15, 1878. The Chamber of Commerce of Paris will establish a general agency for the reception, management, and return of goods. The General Commissioner will not correspond directly with foreign exhibitors. They must address all communications through the commissions of their respective countries.

THE PORTUGUESE MAN-OF-WAR.

At a recent meeting of the Liverpool Microscopical Society, Captain Jno. H. Mortimer, of the U. S. ship Hamilton Fish, an associate member of the Society, exhibited a number of marine specimens which he had presented to the Free Public Museum. He also communicated some interesting facts in connection with the *Physalia pelagica*, known as the Portuguese man-of-war, the tentacles of which are of great length, consisting of a muscular band studded on its margin by rows of beads, each bead being a mass of small spherical cells, each of which contains a small spiral stinging thread, coiled up inside. Portions of the tentacles had been mounted for microscopic examination, and under a power of 500 diameters the cells and spiral contents were easily seen. Captain Mortimer stated that he had frequently witnessed the discharge of the stinging threads from the cells, and that the stinging power was perceptible some days after the death of the animal. He believed that the above facts were new to science.

MICROSCOPIC INSECTS IN THE SKIN.

At a recent meeting of the Entomological Society, London, Dr. F. Buchanan White presented the following account of a case of "Pruritus from an Unusual Cause," by Dr. Tilbury Fox:

"At the end of July, 1876, a gentleman resident in the Eastern counties noticed on the eyelid of his infant a small red speck, which on examination with a hand-microscope proved to be a living parasite, partially imbedded in the skin. Several days subsequently his wife was greatly annoyed by pruritus, and her neck and chest were found studded here and there with these little red specks, which at first sight were thought to be 'petechiæ,' but turned out to be insects. They could be readily extracted with a pin. In the attempt to discover the source whence the parasites came, a pet pug dog was examined, and then collections of these parasites on the nose and between the eyes—where, in fact, the hair was least thick—were discovered. During August the little red visitors caused excessive annoyance to the servants and everyone in the house, defying all remedial measures, though some members of the household were very much less affected than others. Remove them as you would, the next day a fresh supply appeared, and the insects were found on the arms of the infant as well as on the face, on the back, neck and chest, and even the nipples of the adults. A favorite long-haired French cat was examined, because one of the family after nursing it was greatly annoyed, and the ears were found infested. The hair fell off, leaving bald patches where the parasites were congregated on the dog and the cat. In the middle of August the animals were shut up, isolated, and regularly dressed with equal parts of sulphurous acid and glycerin, and the plague began to diminish at once. The members of the household had tried citrine ointment, compound sulphur ointment, detergent solution of tar, etc.; but still the nuisance continued in some degree, and a second cat was found affected. But when all the animals were shut out of the house the mischief did not cease. There was some doubt and difference of opinion with regard to the exact species of the parasite. A specimen was submitted to my friend Dr. Cobbold, and he pronounced it to be *Trombidium*, or garden mite, which lives on plants. It is closely related to the true mites, the itch insect, the little red 'spider of hot-houses,' and the well-known *Leptus autumnalis*, or 'harvest-bug.' The annoying pruritus about the legs produced by the latter at the end of the summer, after a walk in the fields, etc., is well known to every one; and Dr. Heiberg has lately recorded that the nuisance assumed an epidemic form in a village in Denmark. In the present case the pruritus was chiefly around the neck and shoulders, and several parasites were removed from the eyelids. The plants in the garden were not examined to see if plant-mites were very abundant there, as this exact source was not suspected at the time. There can be little doubt, I think, that the original source must have been certain plants in the garden; that the house pets, who were undoubtedly first affected, were agents in the conveyance of the main portion of the parasites to the human members of the family, but not exclusively, the propability being that many of the people, especially after the pet cats and dog were excluded from the house, managed to be infected directly from the original source."

ON THE EYES OF WORMS.

A paper of some interest is that of M. J. Chatin, which was lately presented to the French Academy by M. Milne Edwards. He indicates a series of analogies between the eyes of the annelids and those of crustacea. The eyes of worms present three distinct types: (1) In *Torrea* the eye is extremely perfect, and comprises all the parts that one sees in the eye of Vertebrates. (2) In the various *Serpulæ* the eye is formed by one or more refractive parts placed in a generally elongated matrix. (3) In the *Polyophthalmiæ* the organ consists of one or more analogous pieces, but they are surrounded by a pigmentary mass whose limits are undecided. Now, M. Chatin finds that the second group, that of the *Serpulæ*, presents a marked resemblance between its eyes and those of crustacea. Some genera, as, for instance, *Psygmobranchus*, show the analogy very distinctly. Their eyes are, in fact, formed by a piece in which it is easy to recognize two parts: one *superior*, refractive, corresponding to the crystalline lens of authors; the other inferior, elongated, colored reddish orange (*P. protensus*), and thinning out towards its initial end. If now we compare this with the arrangement in certain of the lower crustacea (*Epimeria*), we easily recognize the complete analogy between the crystalline lens and the cone, and between the *batonnet* properly so called, and the lower part brilliantly decorated as above. The author gives several other instances which support his views.

SPIDER LINES.

At a recent meeting of the Academy of Sciences, Prof. Davidson stated that, when collecting tarantulas last season on Mt. Diablo, he discovered that one of them, whilst walking, was discharging a web. With a frame which he uses in collecting fine spider webs for micrometers, he commenced winding up the web, merely as a specimen for examination; in doing so quite rapidly, he drew the web much more rapidly than it would be discharged by the spider naturally. A light breath of wind showed by the reflected light from the web that he was drawing it so fast that it exhibited itself as composed of many lines, which were united and exhibited as one when the line was drawn out more slowly. By a little dextrous handling he was enabled to spread the lines from the different spinerets upon the bars of the frame, and, upon subsequently counting them, ascertained that there was not less than 28.

Professor Davidson presented also some specimens of small spiders, the webs of which are familiar to all, in being present on freshly plowed ground. The largest are about the size of a grain of wheat, but the majority of them considerably smaller. When the collector of these specimens, Mr. Kuehnle, was watching and experimenting with them, one little black fellow, which he had upon a stick, threw out his fine lines in several directions without reaching any object, but in one of his efforts the line touched the ground and upon the instant the spider went over it with lightning rapidity. Upon another occasion, when sitting upon his plow handle, watching one of these spiders throwing its line to different points unsuccessfully, it finally threw one to the rim of his hat and then instantly mounted the web.—*Mining and Scientific Press.*

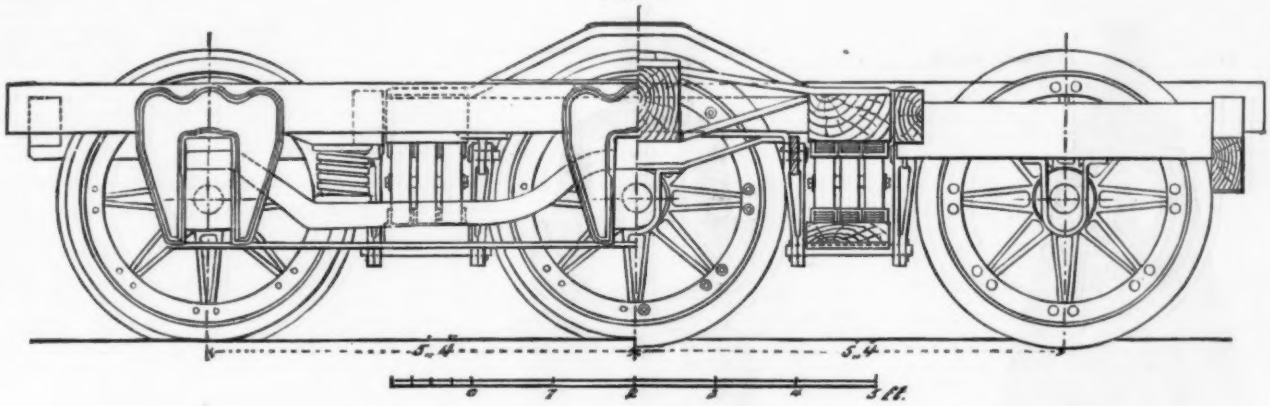
LARGE *VERSUS* SMALL CAR WHEELS.

By Herbert Wallis, Superintendent of the Mechanical Department of the Grand Trunk Railway.

The practice of using 33-inch car wheels is so general that perhaps an assertion that we have, during all these years, been making a very grave mistake may not readily be admitted, and yet a careful consideration of the subject and comparison with work on railways in other countries, coupled with experiment, will show conclusively that there is plenty of room for such an assertion.

Great Britain has introduced our style of cars, both day cars and sleepers, with undoubted success, and it does appear that we shall yet, in return, be taught by her an excellent lesson in the matter of wheels.

Fig. 1.



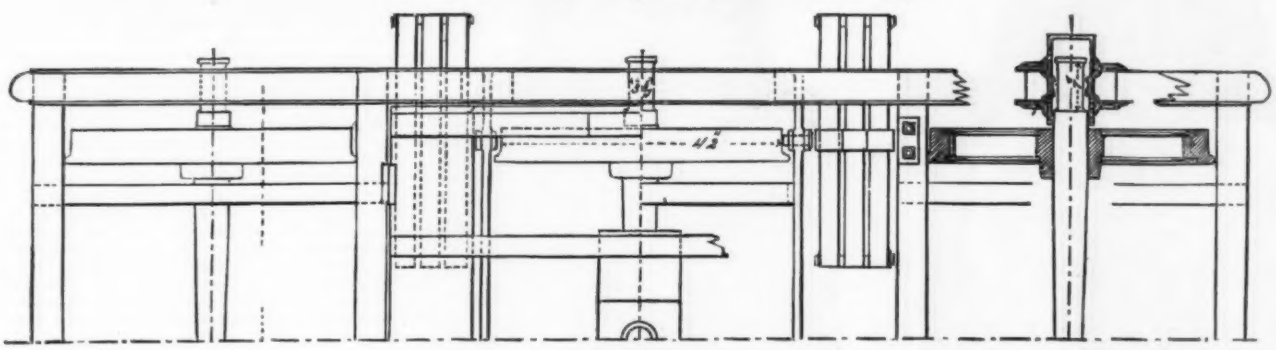


Fig. 2.

Fig. 3.

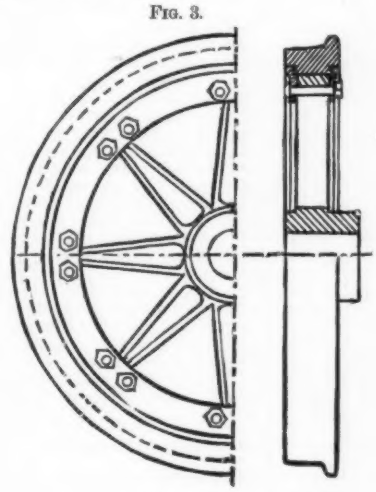
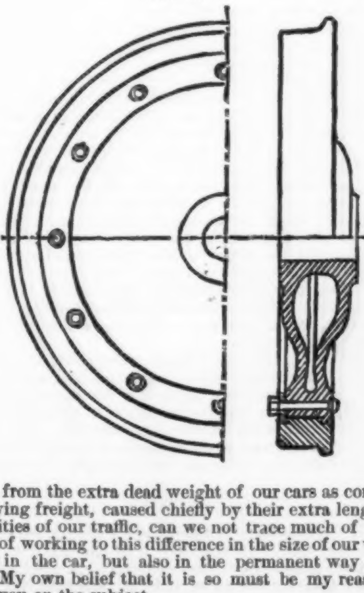


Fig. 4.



Apart from the extra dead weight of our cars as compared with paying freight, caused chiefly by their extra length and peculiarities of our traffic, can we not trace much of the extra cost of working to this difference in the size of our wheels, not only in the car, but also in the permanent way department? My own belief that it is so must be my reason for writing you on the subject.

The average cost of working the car department of English railways for the half year just ended was about 5 cents per train mile, and the cost of maintenance of permanent way about 14 cents; and notwithstanding the larger amount which is annually expended there for renewals, these figures are little more than one half of the cost per mile of American railways.

I am assuming that a wheel of 42 inches in diameter (which is the standard of English railways) is the largest that can be used without raising the height of our passenger cars, and Figs. 1 and 2 show the six-wheeled truck, commonly used under Pullman cars, adapted to this increased diameter.

The advantages in favor of the large wheel, briefly expressed, are as follows:

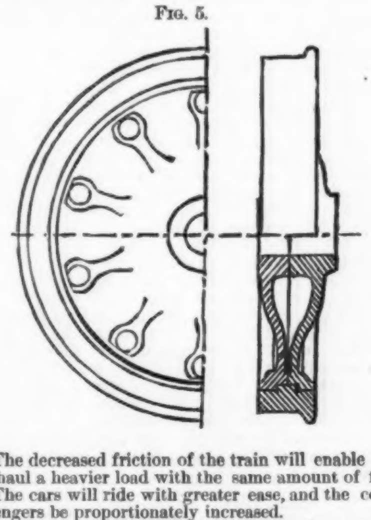
1st. The reduced cost of maintaining the permanent way. This will be readily conceded, when it is considered that not only is the bearing surface of the wheel upon the rail practically very materially increased, but that at a given rate of speed the 42-inch wheel makes 21 per cent. less revolutions.

2d. The saving in maintenance of wheels, with reference to which the remarks on reduced cost of permanent way hold good.

3d. The decrease of frictions on the journals and bearings, due to the reduced speed. The advantage gained under this head, not only in reducing the expense of lubrication, brass and axles, but in, as has been most unmistakably proved, almost entirely doing away with the delay and annoyance caused by hot boxes, would repay the extra outlay incurred.

4th. The gain of car mileage, the cars being less frequently off duty for renewals of wheels.

Fig. 5.



5th. The decreased friction of the train will enable an engine to haul a heavier load with the same amount of fuel.

6th. The cars will ride with greater ease, and the comfort of passengers be proportionately increased.

The experiments made on this road during the past two or three years, and now being made, have resulted in the adoption of a wheel of 42 inches in diameter for passenger car service, and it is desired to use the 36-inch for freight cars.

Without advocating any particular class of wheel, Figs. 3, 4, 5, 6 and 7 show the designs now in use on this railway; and it is now tolerably well ascertained that a wheel on the principle of Fig. 3, 4 or 5, properly constructed, and having a hard tire 3 inches thick, will run without difficulty in Pullman car service from four to five hundred thousand miles.

The cost of such a wheel is little more than three times that of the ordinary chilled one, which, if we assume to average a mileage of fifty thousand, the gain in point of actual economy is fifty per cent. in favor of the large wheel, to say nothing of the saving in operating expenses and the absolute immunity from accident caused by breakage.

The question, however, whether the wheels should be cast iron or steel, or compound with centers of cast or wrought iron, is one to be solved by experiment only, and that, of course, to the satisfaction of the road using them; but it is important that if steel tires be used they should not be less than $2\frac{1}{2}$ and, if possible, 3 inches in thickness.

Although undoubted success has been obtained from the use of steel tires on this railway, what is now advocated is the increased diameter of the wheel only.—*Railroad Gazette.*

APPEARANCE OF SNOW FLEAS.

Charles M Nes, of York, Pennsylvania, writes to the Smithsonian Institution that with the snow fall of the 8th of January (about 12 inches) there appeared myriads of "springtails" or *Podura*, samples of which were inclosed, covering the surface of the snow to such an extent as to entirely discolor it. The phenomenon extended over an area of country two miles in length and half a mile in width. In a later communication Mr. N. says: "They were in clusters, and where I gathered the specimens I had simply to take them up by handfuls; the snow was literally covered. They still exist in great quantities on fences, bushes, stones, etc., in the vicinity where they first fell."

Fig. 6.

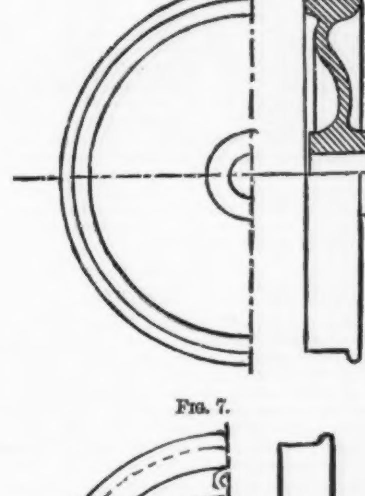
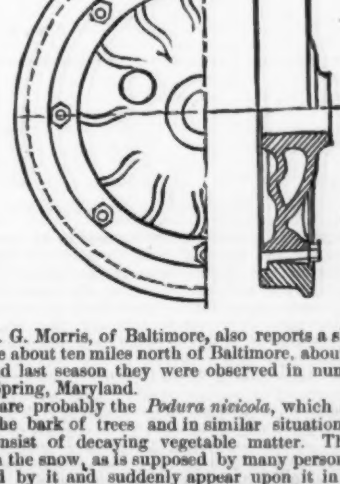


Fig. 7.



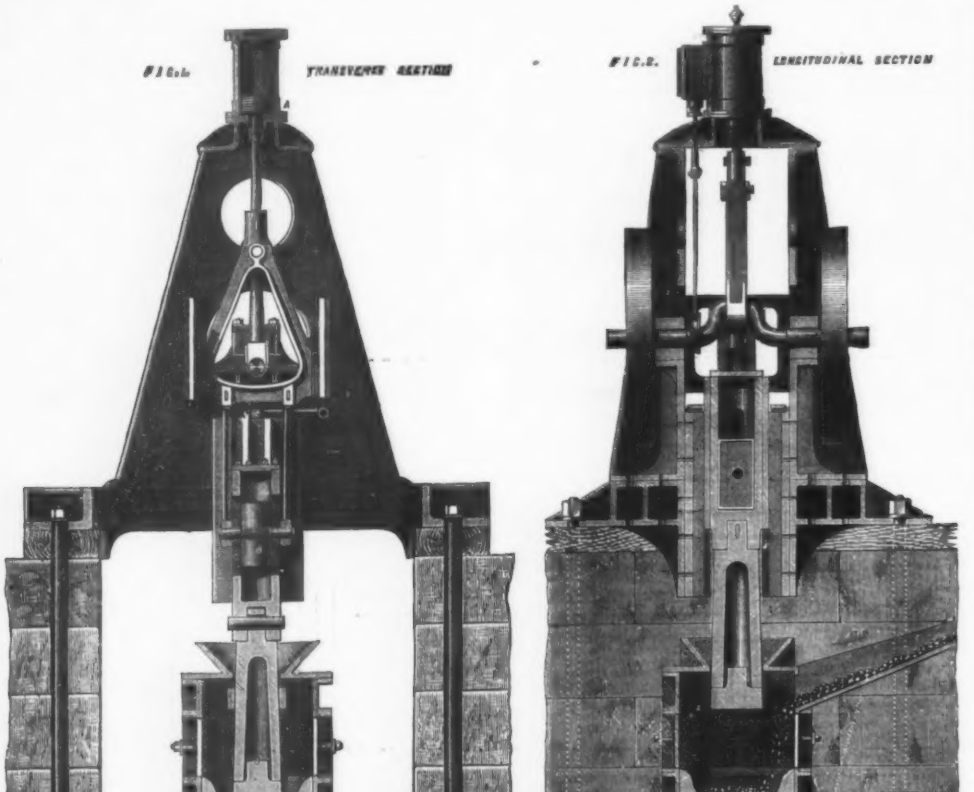
Dr. J. G. Morris, of Baltimore, also reports a similar appearance about ten miles north of Baltimore, about the same time, and last season they were observed in numbers near Sandy Spring, Maryland.

They are probably the *Podura nivicola*, which are found under the bark of trees and in similar situations, as their food consist of decaying vegetable matter. They do not fall with the snow, as is supposed by many persons, but are attracted by it and suddenly appear upon it in countless numbers, becoming at once conspicuous and interesting objects.—*Field and Forest.*

PNEUMATIC ORE STAMPS.

The pneumatic ore stamps which have undergone several improvements at the hands of Mr. Sholl, of Cranworth street, Manchester, England, his direct-acting system embracing, it is claimed, the advantage of less cost, and fewer working parts than any other, and dispenses with separate engine, belts, and intermediate gear.

We give a longitudinal and transverse section of one of these machines for tin working. In Fig. 1 the steam piston A is in direct communication with the pneumatic piston B, which is attached to the bow by outside hangers working in the slots C C. The air entering at the slots is by this means alternately compressed by reciprocation without stuffing boxes or glands, thereby simplifying the machine in one of its most important and hitherto objectionable features. The pneumatic "plug" or piston is cased with brass to guard against the effect of mineral water, and works like a plunger without rings of any kind. The weight of the stamper in this case is half a ton: this will be driven at 120 revolutions per minute, devolving about 130 tons per minute in the pulverizing box or hopper, with an expenditure of about 8-horse power. It is calculated that the amount of ore that will be passed through the grates or sieves, thirty-six holes to the superficial inch, will be about 1 ton per hour, or equivalent to twenty-four heads of the old stamps.—*Engineer.*



SHOLL'S DIRECT-ACTING PNEUMATIC ORE STAMP.

HIGH PRESSURE ENGINES.

The following figures will perhaps bring home to the minds of many the great advantage of using high pressure steam. Some years ago I ordered an eight-horse double cylinder engine, which was to work with 120 lbs on the square inch of safety valve, and for my own guidance I calculated out the power the engine would work up to at various pressures and various expansions, and from that table I select the following, because the quantity of water used in an hour is in each instance very nearly the same:

Pressure on Boiler.	Cut off at	Cubic feet of Water used in an hour.	Horse power done by the Engine.
lbs.			
16	[illegible]	7·73	7·34
33	[illegible]	7·79	11·94
50	[illegible]	7·78	15·32
67	[illegible]	7·75	17·49
105	[illegible]	7·93	22·96
120	[illegible]	7·76	23·90

Now, although the quantity of water used in an hour is as nearly as possible the same, it will be observed that the power exerted by the engine with 16 lbs. steam is only 7¼ horse power, while with 120 lbs. steam the power exerted rises to $23\frac{9}{10}$ horse power, or to more than three times as much with the same expenditure of coal! For the water boiled off in an hour in the same boiler, and under the same fireman, is almost an exact measure of the coal consumed. These figures show that a farmer cannot "economically" reduce the power of his engine by working at a lower pressure, for he will burn the same coals precisely. It is, therefore, desirable for a farmer always to have two cylinders, with convenience for working them together or separately, because in that way he can at once reduce the power one half. The only other way in which an engine can be "economically" reduced in power is to reduce the number of strokes per minute; for if the ordinary speed of an engine is 200 feet per minute, and you reduce that to 100 feet, you at once halve the power and also halve the coals burnt. But the machinery which requires only a small power to work it—the chaffcutter, for instance—must be arranged for a very low speed in the flywheel of the engine; that is to say, it must have on a much smaller driving pulley than usual. If you have two cylinders you can always reduce the power to one half by using one cylinder only, and if you halve the speed you can reduce it to one fourth. Thus in the above engine I could cut down the power from 24 horses to 6 horses, and yet work with the lowest possible expenditure of coal, namely, with 120 lbs. steam cut off at one eighth of the stroke, and therefore expanded eight times.—*G. A. H., in Agricultural Gazette.*

DETROIT WATER WORKS.

From the annual report for 1876, of D. Farrand Henry, Chief Engineer of the Detroit (Michigan) Water Works, we glean a few facts of interest. Total pipage of the city, 187½ miles, of which 94¼ miles is iron pipe, and 92⅝ miles wooden logs. The present pumps and mains will supply about 22,000,000 gallons in 24 hours; but if a little time is taken for cleaning and rest, as at present, not over 20,000,000 gallons a day could be furnished. If the city grows in the future as in the past, this limit will soon be reached, and unless another pump and main are shortly commenced, some cold winter's day both the old and new works will have to run to supply the demand. Families assessed, 20,102; not assessed, 364; showing that nearly the whole city is supplied with water. The number of gallons of water pumped this year was 142,119,790 less than in 1875. The past winter was quite mild, and few services were frozen, while the maximum demand occurred in the month of July. The daily supply per inhabitant was 101·8 gallons, which, although 5·8 gallons less than in the previous year, is still enormous. The maximum amount pumped in one day was on the 15th of July, 13,540,800 gallons, over 3,000,000 gallons less than the maximum of the previous year, which occurred during the cold spell. The mean quantity pumped for the year was 11,107,499 gallons, or 3·7 per cent. less than in 1875, but 23·2 per cent. greater than for 1874.

A table showing the number of gallons distributed in the several years from 1852 to 1876 inclusive is given, from which we extract the last ten years:

Year.	Galls. water pumped.	Average daily delivered.	Galls. of water for one cent cost of fuel.
1867.....	1,425,535,290	3,905,576	$1,408 37
1868.....	1,666,545,125	4,507,248	1,464 55
1869.....	1,646,810,325	4,511,209	1,464 10
1870.....	1,866,060,068	5,112,493	1,467 74
1871.....	2,300,150,605	6,301,782	1,567 42
1872.....	2,782,292,578	7,601,892	1,453 64
1873.....	3,198,393,948	8,762,723	1,580 76
1874.....	3,289,872,635	9,013,350	1,610 18
1875.....	4,207,454,260	11,527,272	1,966 73
1876.....	4,065,334,470	11,107,499	2,049 79

This table also shows careful water takers that they not only have to pay for all they consume themselves, but also for what their neighbors waste. The cost of pumping each million of gallons has been $7.33; or taking the average lift at 90 feet, of raising the same 100 feet high, $8.16.—*Engineering News.*

A reward of five thousand dollars is offered by the London General Omnibus Company for an invention that will effectually record and check the receipts of passenger fares.

PHYSICAL SOCIETY, LONDON.

Professor W. G. Adams, Vice-President, in the chair.

INTERFERENCE WAVES.

Professor Guthrie exhibited for Mr. C. J. Woodward an apparatus he has devised for showing to an audience the interference of transverse waves. A light frame, capable of moving in a vertical plane, carries a horizontal strip of tin about two feet in length, cut in the form of the ordinary sine wave, and which supports, by means of a roller, a light wooden block, carrying an ink recorder in front of a sheet of paper. This block slides in a vertical slot in a piece of wood, which can be moved horizontally, supported by a roller on another similar strip of tin, fixed parallel to the first, and vertically below it. The movable frame rests on a castor, attached to this block. If the relative positions of th waves be now varied and the blocks moved along them, the path traced by the ink recorder will represent the wave due to their combination.

VAPOR TENSION OF WATER.

Professor Guthrie exhibited an arrangement he has been using with a view to determine the vapor tension of water, and explained the difficulties to which such a determination is liable, and the manner in which his apparatus has so far failed. It was shown that a crystal of alum, or a saturated solution of salt, when introduced into the Torricellian vacuum, depresses the mercurial column less than pure water, whereas a solution of size, gum arabic, or any colloid, depress it to precisely the same extent. It thus appears that water in its different states of combination has different vapor densities, and their determination requires an arrangement in which the several substances can be easily introduced into the Torricellian vacuum, and very slight changes of the level of the mercurial column can be ascertained. He then showed the manner in which electricity is distributed on non-conductors, such as the plate of an electrophorus, by placing it for a given time beneath a point connected with a charged Leyden jar, and subsequently sprinkling a mixture of sulphur and litharge over it. It was shown that the diameter of the circle formed below the point after the superfluous powder had been removed, is not purely a function of the distance between the point and the plate, but is mainly influenced by the conductivity of the material; and further, that if the point be directed obliquely towards the plate, the circle formed is very slightly elliptical, but the ellipticity is in no degree proportionate to the obliquity of the point; and, finally, he showed that if the non-conducting plate of an electrophorus be written upon with a metal and sprinkled with the aoove mixture of sulphur and litharge, the former or latter adheres according to the nature of the metal used.

POLARIZATION OF HEAT-RAYS.

Prof. Foster showed experimentally the polarization of heat-rays, employing Nicol's prisms of 2⅝ in. aperture, and a thermopile surrounded by a double jacket and connected with a Thomson galvanometer, as arranged by Mr. Latimer Clark for showing slight indications to an audience. When the principal sections of the prisms were at 90° to each other, only a slight movement—doubtless due to an initial heating of one side of the pile—was observed; and the amount of the deflection was found to increase steadily up to about 60 divisions on the scale as the above angle was diminished. Prof. Foster exhibited the results of experiments made to determine the intensity of a source of heat by this means, and they were very concordant.

Mr. Latimer Clark then explained the arrangement of the galvanometer used. The image of an arrow-head, or other form of index, projected by means of a lime-light at the further end of the room, traverses a telescopic object-glass about 2 ft. distant from the lamp, and falls on a square silvered plate of glass suspended from the needle of a Thomson galvanometer, which is rendered steady in the ordinary way by a platinum spade in water. The reflected image then traverses the whole length of the room, and falls on a large scale placed in front of the audience, and, by such an arrangement, the instrument may be at any distance from the scale and yet the image will not be unduly magnified. A method is employed for bringing the needle rapidly to rest. A few thermo-electric couples are placed above the lamp-chimney, thus beinging kept constantly hot, and the terminals are united by a wire which is coiled several times round the galvanometer; the circuit is completed at the moment when this subsidiary current will tend to neutralize the motion of the needle.

THE HOLTZ ELECTRICAL MACHINE.

Mr. Wilson explained difficulties he met with in constructing a Holtz electrical machine, especially with reference to the windows and armatures; he exhibited two machines which he recently made, from one of which a spark 5 or 6 in. in length can be obtained: this apparatus is so arranged that it can be taken entirely to pieces and placed in a very moderate sized case. After carefully pointing out the difference between an ordinary machine and the Birch machine, he proceeded to consider the theory of the Holtz machine, and explained how he was led to construct an instrument in which there were no windows, the armatures being placed on the face of the fixed plate next to the moving plate, but the result was not satisfactory. He then made the larger machine provided with six fixed and six moving plates, and the windows were replaced by holes ¼th in. in diameter, traversed by short pieces of tape glued to the paper armatures. The initial charging of the armature is effected by means of a disk of ebonite fixed to the main axis of the machine, which is lightly held by the fingers and caused to rotate. Electricity is thus generated, and points projecting towards it and communicating with points in the neighborhood of the armature cause them to become charged; after this electricity is generated with great rapidity.

Prof. McLeod gave some details concerning the working of a large Holtz machine which he drives by a turbine. He finds that after it has been in action for nearly an hour, a much greater force is required to work it, and he suggested a theory in explanation of this phenomenon. By keeping the machine dry, under a glass shade, reversing effects are entirely avoided, as well as the necessity for varnishing the plates.

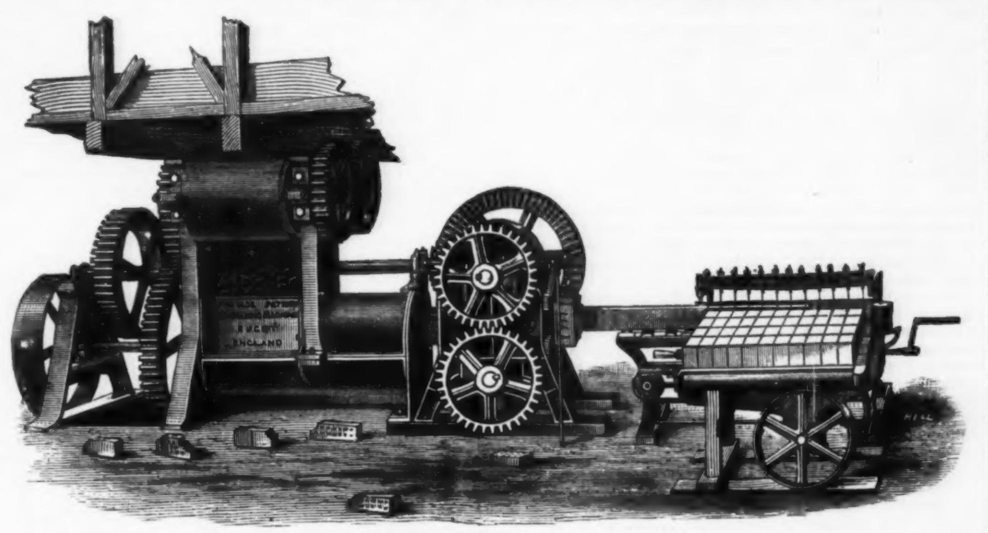
GALVANOMETER.

Mr. S. P. Thompson exhibited some galvanometers in the form of magic lantern slides, which he has arranged for exhibiting their indications to an audience. A gold leaf electroscope of this form was capable of detecting very small charges of statical electricity.

PINFOLD'S BRICKMAKING MACHINERY.

We illustrate a combined crushing, pugging and brick-making machine, by J. D. Pinfold, of Rugby, Eng. This machine unites in one compact and simple construction a variety of methods of treatment of the clay usually done by two or more separate machines. The treatment of a stiff clay which is sufficiently moist to mould properly, and yet not be injuriously yielding, requires a construction of machine as little as possible liable to shock or breakage. This principle is well carried out in Pinfold's machine. His mode of operating is as follows:

The clay in its rough state having been drawn up by the hoisting gear (used in connection with the machine), or otherwise brought to the machine, is fed into a massive pair of grinding rolls, which thoroughly crushes the clay and all it contains. The arrangement for adjustment is very simple, and at the same time very effective, inasmuch as the contrivance for setting the distance of the rolls apart also answers the purpose of a safety apparatus, so that in the event of a piece of iron or other foreign substance larder than ordinary pebbles or small stones getting between the crushing rolls no harm can result to the machinery. This is a great improvement over the majority of crushing mills at present in use. The ground clay then falls from the crushing rolls into the pugmill, which is fitted with a very strong wrought iron shaft, to which is attached a series of strong wrought iron blades and driven by correspondingly strong wheels, so as to enable the use of the clay in the stiff condition necessary for making good sound well-shaped bricks. After having been thoroughly mixed in the pugmill, the clay is fed by it into the compressing rolls, the action of these rolls is such that while they push the clay towards the die they expel every particle of air, and thereby prevent the loss of bricks from the expansion of air during burning (a very common occurrence with bricks made by the dry processes or the piston or pug-propelling plastic machinery). The easy issue of the clay is provided for by a suitable steam or water lubrication, which gives also the issuing stream a most effective surface polish. The clay is now a rectangular block only requiring to be cut into the required thickness.



PINFOLD'S BRICK MACHINE.

The cutting table is ingenious. In this machine the bricks are cut with perfect accuracy (while travelling) from the continuously advancing stream of clay without the use of any preliminary cutting wire, thereby doing twice the amount of work at half the usual cost. The bricks, after they are cut off, are delivered either on to a special bearing-off barrow, ready for wheeling away, or are put on to the separators, so that the bricks may be carried to the drying stoves and mechanically separated without any separate handling.

The machine we illustrate will, it is claimed, make from 20,000 to 30,000 first-class solid bricks per day of ten hours, the quantity, in a measure, being regulated by the industry of the men employed; the labor required to make the former quantity is three men in the mine, one at the top of the incline, one to work the cutter and load the barrows, and three men and three boys to wheel away and wall.

These machines will produce either solid or perforated brick moulds, or drain tiles, or anything, in fact, that can be expressed from a die. We may mention that the clay used is so stiff in this machine that the bricks may be stacked at once for drying six or eight high without injury to their shape.—*Iron.*

NEW PUMPING ENGINE.

NEW PUMPING ENGINE.

We give a view of a very neat arrangement of pumping engine, adapted for feeding boilers and similar work, by Pearn & Co., Manchester. There are two cylinders and two plunger pumps, these being supported by a central standard, which forms the delivery air vessel. The valves are arranged so that they can be very readily got at, and the whole design is very neat and substantial.—*Engineering.*

MILL FOR SOFTENING MIDDLINGS.

It will be observed by reference to the sketch that there are two pairs of rollers, each pair having its own function. The two inner rollers have fixed bearings, while the bearings of the two outside rollers are movable, to which two lever springs are attached, which can be regulated by the hand-wheels and screws at the lower end of the machine. The middlings in passing from the hopper are equally distributed by the feeding rollers on to the two pairs of softening rollers. The distinctive feature of the new invention is the application of differential speeds, which is effected by small pinions attached to the fixed rollers, gearing into the pinions of the movable rollers, which have a larger circumference, and consequently move with decreased velocity. From this description of the difference in the diameters of the pinions, it is obvious that the speed of the outside rollers is reduced, and from the peculiar grit or "cut" of the porcelain, a slight "tearing" action is produced between the surfaces of the rollers. A driving pulley, the speed of which is 180 revolutions per minute, drives the inner rollers. The speed of the outside rollers is about 160 per minute, making a difference of twenty revolutions per minute in the speed of the respective rollers, which produces the exact amount of tearing action required.—*Miller.*

MILL FOR SOFTENING MIDDLINGS.

THE AGE OF THE ROCKY MOUNTAINS IN COLORADO.

1. In very early time in Colorado there was Archæan land rising above the Paleozoic sea. As the Carboniferous age progressed this land diminished by encroachment of the sea, due to subsidence of the land. This subsidence continued through Triassic, Jurassic, and Cretaceous time into the early Tertiary.

2. At the close of the Lignitic there was a physical break followed by a subsidence (at least locally), and subsequently by elevation, after the deposition of the Miocene strata.

3. The elevation of the Rocky Mountains, as we now see them in Colorado, is the result of an elevation commencing in early Tertiary time, and continuing through the period, accelerated perhaps at the close of the Lignitic, and after the deposition of at least Lower Miocene strata.*

The elevation of the mountains was probably gradual as a general movement.

It is an interesting fact that Colorado has a higher mean elevation than any other State or Territory in the United States, and that we find there the highest mass of mountains, and that the evidence points to the fact that in Paleozoic time also we had here one of the highest areas, thus confirming what Dr. Newbury has already intimated, that the outlines of the western part of the North American Continent were outlined from earliest Paleozoic time.—*A. C. Peale, in Amer. Jour. of Science.*

* This elevation is probably going on at present also.

[JOURNAL OF GAS LIGHTING.]

PIPES FOR GAS AND OTHER PURPOSES.

(Continued from SUPPLEMENT No. 66).

AT the close of our last, we referred to the method of jointing with Russian tallow. The metal of the socket in this case need not be stronger than that in the body of the pipe. Several coils of spun-yarn, covered with putty or very thick paint, are first driven into the bottom of the socket. Tarred gasket, made of such a thickness as to fit tightly into the annular space between the spigot and the socket, is then calked round the lip of the latter in such a manner as to leave about 1½ inches of space between the yarns. On the upper side of the pipe the ends of the gasket are drawn out to form a mouth, and a mixture of two parts of melted Russian tallow and one part of common vegetable oil being poured, while warm, through the mouth, runs into and fills up the space all round. Fig. 19 shows the complete joint; the light portions of the plugging being the yarns, and the dark portion between them the tallow.

In the earlier days of gas lighting, after the objections to the use of the rigid flange joint had become apparent, the lead joint, as described in our last week's article, was invariably employed in the laying of mains. Even at the present day, some managers prefer this before any other. Whilst admitting, and that not unreservedly, its excellence when carefully made, and its value and utility under certain extreme conditions, such as the subsidence of the ground in which the mains are laid, we believe that, in a general way, it cannot be compared with the bored and turned joint, either on the score of cheapness, tightness, or durability. It is much to the credit of the late Mr. Alfred King, the able engineer of the Liverpool Gas Works, that he was first to apply this latter description of joint, having adopted it as far back as the year 1826. These are universally in use in the streets of Liverpool and Manchester, where the traffic is enormous, and where defective and insufficient joints would be particularly objectionable.

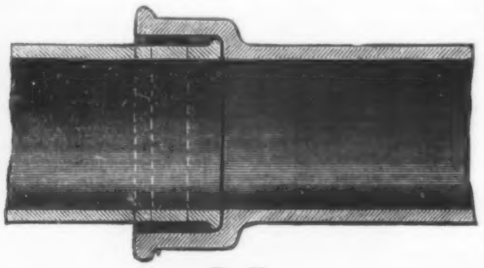


FIG. 19.

It is sometimes urged, in opposition to the turned and bored joints, probably by those who have had least experience in their use, that, owing to the contraction of the metal in winter, the pipes are drawn, and that heavy leakage is the consequence. If there is any foundation of truth in this allegation, it arises from defects that need not necessarily present themselves.

The failure of some of these, in places where they were adopted for the first time, was due to the circumstance of the surfaces having been made too tapering in form. It is well known that the more conical a plug is made the easier it is of displacement from its seat, and the wider the interval between its surface and that of its seating produced by an equal extent of withdrawal. So in the matter of which we are treating, the nearer the two surfaces can be kept to the true cylindrical shape the better, not only for ease in connecting, but in permanent efficiency and tightness. We know, as a matter of fact, that leakage rarely occurs with properly constructed—that is, all but cylindrical—joints, such as we have described.

It must be remembered that there is a lateral as well as a longitudinal contraction of the metal; and as the socket of the pipe has a greater bulk of metal than the spigot, it follows, as a natural consequence, that it contracts to a greater extent than the other, so retaining soundness of the joint notwithstanding the drawing of the pipe end from its original seat.

As a general rule, then, it may be asserted that pipes with bored and turned socket and spigot joints are superior to all others for gas mains. Their first cost is not more, or but a trifle more, than open joints. The speed, certainty, and cheapness with which they can be made far exceed most others in these respects. The soundness and durability of the joint is undoubted, and the ease with which it can be taken asunder, without damaging the pipes, in cases of renewal and enlargement of mains, is not its least recommendation. The bored and turned joint is easily manipulated so as readily to follow any ordinary curves, but when these are sharp and angular an occasional lead or iron cement joint has to be employed.

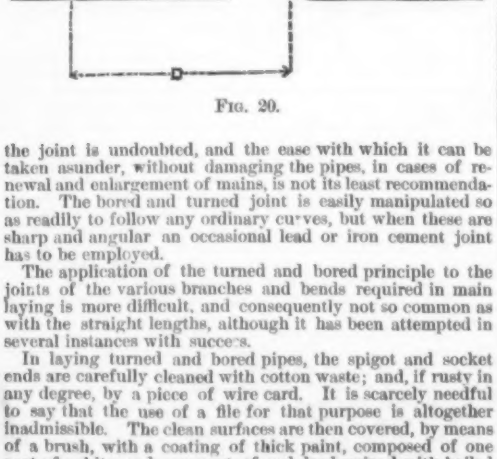


FIG. 20.

The application of the turned and bored principle to the joints of the various branches and bends required in main laying is more difficult, and consequently not so common as with the straight lengths, although it has been attempted in several instances with success.

In laying turned and bored pipes, the spigot and socket ends are carefully cleaned with cotton waste; and, if rusty in any degree, by a piece of wire card. It is scarcely needful to say that the use of a file for that purpose is altogether inadmissible. The clean surfaces are then covered, by means of a brush, with a coating of thick paint, composed of one part of white and one part of red lead, mixed with boiled linseed oil. The pipe is then lowered into the trench, the end inserted and driven home with a mallet if the pipes are of small diameter, or with a swing tupping-block if large.

In driving the pipes, they will sometimes be found to spring back at every stroke. This may be due to one of two causes—either the joint is too conical in form, as previously mentioned, or there is a slight ridge or roughness left on the inside edge of the bored part of the socket or turned portion of the spigot. This latter can easily be removed with a chisel; but the former is a radical defect that is incurable—a permanently close and durable joint under the circumstances being impossible.

One great merit of the turned and bored joint is the ease and facility, and the consequent saving in cost, with which pipes can be joined by its aid. This economy would, of course, go for nothing if the after results of the system were unsatisfactory; but when it is found that the economy is supplemented by efficiency, then we realize the full value of the work.

We have no hesitation in speaking strongly on this point, having had a long and varied experience with the different joints, under the most opposite conditions of soil, situation, and temperature, in recommending the general adoption by managers and engineers of the bored and turned joint in the laying of ordinary gas-mains, resorting to the use of lead, or of iron cement, in the jointings of the various branch-pipes and bends.

In a paper read before the British Association of Gas Managers in 1868, by the late Mr. Rafferty, of Manchester, whose experience on all matters connected with main and service laying was very great, the following estimate of the saving effected per joint, in laying a 30 inch diameter turned and bored, as compared with a lead-jointed main, is given. The particulars of the items dispensed with, and which are required in making a lead joint of the size named, are as follows:

	£	s.	d.
54 lbs. of lead at 2·4d.	0	10	9½
White yarn, 4½ lbs., at 8d.	0	3	0
Making calking chamber	0	1	9
Melting lead and making joint	0	0	10
Quarter cwt. of coal	0	0	2
Extra soil to be carted away	0	1	1½
Flagging or pavement taken up and re-laid, 3 yards, at 1s. per yard	0	3	0
	1	0	8

Since the year mentioned, the cost of both labor and material has increased, consequently the gross saving of the turned and bored over the lead jointing will be greater at the present time than is represented by the above sum. An allowance ought to be made in the calculation for the cost of the red and white lead paint used for coating the turned and bored joint of the size given. A sum of 4d. will be ample for this purpose.

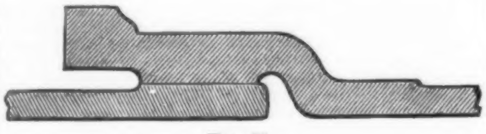


FIG. 21.

We append the usual table giving the approved thickness of metal in the sockets, and also in the body, of turned and bored pipes of the different sizes, from 2 inches up to 20 inches, the accompanying engraving (Fig. 20 explaining the particular parts to which reference is made. The depth of the socket is also stated in each instance.

Table of the Thickness of the Metal and the Depth of the Sockets (inside measure) of Turned and Bored Cast-Iron Gas-Pipes.

Dia. of Pipe.	A	B	C	D	Dia. of Pipe.	A	B	C	D
Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.	Ins.
2	5/16	7/8	1/4	3	10	9/16 full	1¾	7/8	4½
2½	3/8 bare	15/16	9/16	3¼	11	9/16	1 13/16	15/16	4½
3	3/8	1	5/8	3½	12	9/16	1 13/16	15/16	4½
3½	3/8	1⅛	5/8	3¾	13	9/16 full	1⅞	15/16	4½
4	3/8 full	1¼	11/16	4	14	9/16 full	1⅞	15/16	4½
5	3/8 full	1⅜	11/16	4	15	9/16 full	2	1	5
6	5/16	1½	3/4	4½	16	5/8	2	1	5
7	5/16	1 9/16	3/4	4½	17	5/8	2⅛	1 1/16	5¼
8	5/16	1⅝	13/16	4½	18	11/16	2⅛	1 1/16	5¼
9	5/16	1 11/16	7/8	4½	20	11/16	2¼	1⅛	5½

It is sometimes preferred by engineers to combine the turned and bored with the lead or cement joint, by having the socket of the pipe cast with a recess in front of the bored part of about 1½ or 2 inches in depth (Fig. 21), so that in the event of leakage from the turned and bored portion of the joint, it may be supplemented by a plugging of other materials—either lead, iron, cement, or Portland cement. If the pipes are of good quality, being obtained from a manufacturer of repute, and proper care bestowed upon the boring and turning, there is no necessity for this; though it must be admitted that, in many instances, these indispensable conditions as to quality are not observed.

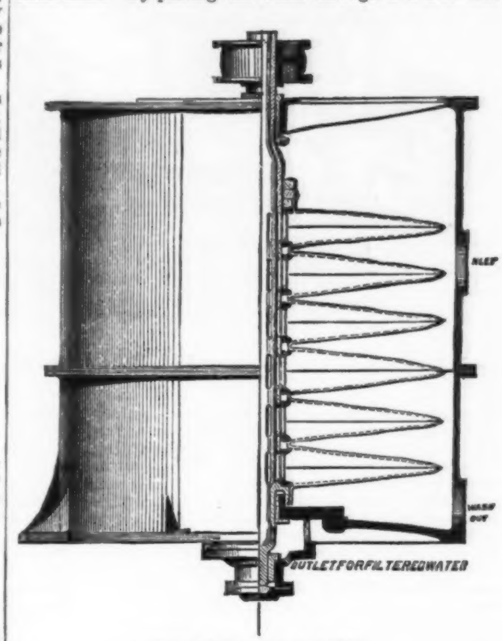
NEW ROTARY FILTER.

FOR filtering the grosser suspended impurities from water in large quantities, nothing has been found more effectual than bagging or cloth of a strong but not very close texture. For waterworks, settling tanks, or reservoirs, it has been hitherto employed, but the objection to this form of preliminary filter is the space and time occupied. Various expedients have been resorted to for filtering large quantities of water for baths, etc., and the difficulties attending the cleaning, bagging, or other filtering medium, when it has become clogged after a few minutes or hours of work, according to the quantity of matter in suspension, have not been effectually overcome. The filter we illustrate has been designed by E. Perret, of Abingdon street, Westminster, London, to overcome these difficulties, and one has now been in successful operation about six months at the Swimming Baths, King's Road, Chelsea.

The machine consists, as will be seen by our engraving, of a series of pairs of perforated copper disks, strung on a central hollow spindle provided with a pulley, and capable of rotation, the whole being contained in a circular tank. Over the disks is stretched the filtering material, which in this particular machine is filter cloth, and which is tied in between the disks, thus following their shape.

The liquid to be filtered is let into the spaces outside the disks, and passes through the cloth into the hollow spindle and hence into a tank below, leaving its impurities on the outside of the cloth. When the cloth is choked—the time in which this is effected, of course, varying with the quantity of impurities in the water—the external water is run off, and the spindle rapidly rotated; the dirt, by this means, is thrown off, and a little water being applied, either internally through a central sparge pipe or from an external pipe, the cloth is perfectly cleansed, and the mud washed away.

During a recent experiment, a large quantity of Thames mud was mixed with the water in the filter tank, the water running from the filter nearly equal to that taken from the street main. By passing the water through a bed of charcoal, which, it seems, remains effective for practically an unlimited time, the water is rendered quite limpid. In about 40 minutes about 2,000 gallons of water charged with 25 grains of matter in suspension to the gallon passed through the filter, which has 200 ft. of surface, and the filter was cleaned ready to recommence filtering in about two minutes.



NEW ROTARY FILTER.

It is not, of course, pretended that this arrangement of cloth filter will do more as regards purification than has already been done by similar filtration; but the great disadvantage attending the use of filters for such very impure or turbid water has been overcome by supplying a means whereby the filter cloth may from a clogged state be cleansed and made ready for recommencing its work in an exceedingly short space of time. Thus, in fact, making it possible to deal with large quantities of water in a small space.

At the Chelsea Baths the filtering of the warmed water from the swimming baths is a matter to the proprietors of great importance, as, without some efficient filter, the water once used must be allowed to go into the sewers, carrying with it all the heat imparted to it, and which at considerable expense must be given to a continually renewed quantity of cold water. Of course new water is continually being added to that filtered, but, as above stated, the preliminary work of the machine illustrated, which reduces the impurities to from 2½ to about 4 grains per gallon, is supplemented by a charcoal filter. In the hands of large consumers of water the machine promises to become an important one, as it is of great assistance by giving them a ready means of dealing with their supplies, and more especially when they become, owing to floods, etc., seriously impregnated with matter in suspension, which would choke and render useless an ordinary filter in a few minutes or hours at the longest. In cases where it is advantageous to use the Clark process for softening water, the lime may, according to the inventor, be mixed with the dirty water, and the carbonate removed with the mud filtered out.

We understand these machines can be made continuous in their action if required, special arrangements being made for dealing with sugar, sewerage, etc., where it is desired to utilize the matter filtered out. The total cost of filtering by this machine is estimated at 1d. per 1,000 gallons, including the cost of pumping the water into the filter, and the cost of renewals, depreciation, etc.—*Engineer.*

THEORY OF THE BUNSEN LAMP.

AT a recent meeting of the Chemical Society, London, Professor Abel, F.R.S., President, in the chair, Prof. Thorpe gave his lecture "On the Theory of the Bunsen Lamp." The speaker, after some preliminary remarks as to the great value of this lamp, both to the scientific chemist and in the arts, pointed out the origin of it at the time when Bunsen introduced coal-gas into his laboratory: he considered the contrivances which had been used in this country as unworthy of the fuel they had to burn, and, bringing his own inventive powers to bear on the subject, the Bunsen lamp was the result; the original apparatus differing but little from that now generally in use. After a short description of the lamp, the mode by which the air is drawn in at the holes at the bottom, and caused to mix with the gas, was considered. This is due to the well-known fact that when a gas issues from an orifice under pressure it carries with it more or less of the circumjacent air, partly as the result of the expansion, and partly as the result of its viscosity. This was experimentally illustrated by an ingenious adaptation of List's multiplying manometer, which, when connected with one of the holes at the base of a Bunsen lamp, distinctly showed the rarefaction produced by the gas as it issued from the jet, despite its low pressure. The intermixture of the gas and

air in the tube is greatly facilitated by the spreading out of the gas-stream after leaving the jet, and the amount of air carried in varies of course with the size of the air-holes, being in an ordinary burner from 2 to 2½ times that of the gas. An average lamp, giving a flame 120 m.m. high, burns about 80 litres of gas per hour, so that as much as 250 litres of mixed gases pass through the tube of the lamp in that period of time. In some modifications of the lamp, such as Wallace's, the proportion of air is very largely increased, but then it is necessary to resort to some such contrivance as a perforated cap to prevent the flame retreating down the tube and burning below; for from Mallard's observations on the maximum rapidity of the propagation of combustion, it is evident that the velocity of the current of mixed gases in the tube of the Bunsen lamp would have to exceed that of the velocity of the propagation of combustion, in order that the flame should not retreat down the tube. Having traced the progress of the mixture of air and gas up the tube, attention was directed to the flame itself, which is hollow, and contains a large internal area of the uninflamed mixture, as it has been found that a mixture of gas with less than 3½ times its volume of air will not burn; it is only, therefore, when it meets with an additional supply of oxygen from the surrounding air that combustion occurs. The composition of the gas in the uninflamed interior cone is not the same in every part, however, as has been shown by Blackmann, the amount of hydrogen, of the hydrocarbons, and of oxygen diminishing, and that of the carbonic oxide, carbonic acid, and especially the aqueous vapor and nitrogen, being largely increased, the latter being derived from the surrounding air. This was still more clearly shown in a table giving the amount of air mixed with 100 vols. of gas, both in the tube and at various distances above it. The cause of the rapid diminution in the proportion of hydrogen, and the corresponding increase in aqueous vapor, is to be sought for in the greater diffusive power of the gas, and the lower ignition point of a mixture of hydrogen with air. If the supply of air be cut off from the air-holes at the bottom of the Bunsen lamp, the flame becomes luminous, so that the non-luminosity of the flame is due to the air, and at first sight it would be imagined that it was due chiefly, if not entirely, to the oxygen in the air, since it is known that an admixture of air with coal-gas greatly decreases its luminosity; the nitrogen, however, is concerned in the matter, for if, instead of supplying air at the holes at the bottom of the lamp, we supply nitrogen, or even steam, the flame at once ceases to be luminous, showing that the oxygen of the air is not necessarily the true cause. Knapp has shown that any indifferent gas, as carbon dioxide or hydrochloric acid, will produce the same result. Frankland proved, many years ago, that a mixture of marsh gas and air, which was almost destitute of illuminating power, might be made to give a luminous flame by heating the gas to redness, and Wibel has recently shown that the ordinary Bunsen flame is luminous when the gas is previously heated. This fact was experimentally illustrated by means of a Bunsen lamp with a platinum tube: when the latter was heated to redness, by means of a blowpipe, the flame became luminous, as when the air supply is cut off from the holes at the base. The feeble luminosity of the Bunsen flame would appear to be due to a variety of causes, such as the oxidation of luminiferous material, the action of the nitrogen and other diluting gases, and the withdrawal of heat by the indifferent gases, such as nitrogen, carbon dioxide, and water vapor, for, although the temperature of a flame of coal-gas mixed with air is higher than that of one of unmixed coal-gas, it requires a still higher temperature in order to become luminous. When the gas is lowered in the Bunsen lamp, and the flame becomes very small, it will be seen that it does not rest immediately upon the end of the tube—a fact due to two causes, namely, the cooling action of the tube, and to the velocity of ignition of the mixed gases being less than the rate at which they issue. When the flame is very small, we all know that the least current of air causes the flame to retreat down the tube and ignite the gas at the jet below; this is due to an admixture of air causing the velocity of ignition of the mixed gases to become greater than the rate at which it passes upwards in the tube. When the flame burns at the bottom a very much smaller quantity of air passes into the tube, and the gas which issues at the top is entirely deprived of oxygen, and has, moreover, a disagreeable odor arising in part from the presence of acetylene formed by the imperfect combustion of some of the hydrocarbons present: the amount of carbon monoxide is also very largely increased. The pernicious effect of this partially burned gas is due to the acetylene and carbon monoxide thus formed.

The President, in thanking the lecturer, remarked that it would have been difficult to select a subject having a more special interest for working chemists; he had brought before them facts with which many were only generally or very partially acquainted, and made them familiar by his explanations and admirable experimental illustrations. Of those points of interest in the theory of the Bunsen lamp which had been mentioned, perhaps those bearing on the luminosity of flames were of the greatest interest at the present time, when so much attention was being directed to the subject.

Dr. Frankland said that, although he had not paid any special attention to the luminosity of the Bunsen flame, it had been a point of special interest to him to ascertain the cause of the greater or less luminosity of flames under certain conditions. With regard to the effect of dilution on the luminosity of the Bunsen flame, it had been advanced that when gases containing oxygen had been employed, such as carbonic anhydride, they had given up their oxygen, but there could be no doubt that this was not the case when nitrogen was used. From his own experiments, it was evident that a comparatively slight elevation of temperature has a great effect on the luminosity of a flame which was just on the point of becoming luminous. He had resumed his researches on the luminosity of flames, and might say that he had repeated the very important experiments of Heumann, whose details of results he had found to be most accurate. He might mention that the exceedingly luminous flame of phosphureted hydrogen did not give the faintest shadow in bright sunlight, showing that no solid matter was present in it; but as to whether the luminosity of carbonaceous flames was due merely to the great density of the hydrocarbon vapors, or to solid particles of carbon, was a matter which must still be considered as *sub judice*. The two important points to be determined were the presence or absence of polarized light in carbonaceous flames, and as to whether a flame whose luminosity was undoubtedly due to the presence of solid particles would behave in the same way under diminished pressure as hydrocarbon flames, such as that of a candle, etc.

Mr. Vernon Harcourt wished to ask the lecturer whether the luminosity of the Bunsen flame, when the tube was heated to redness, might not be due in part to the formation of tarry matters or of hydrocarbons containing a large proportion of carbon, as it was not possible that the mixture of gas and air could be passed through the red-hot tube without undergoing considerable change.

Dr. Wright suggested that the effect of heating the tube was comparable with that produced by lighting the jet below.

Prof. Thorpe replied that Heumann had very carefully examined into the matter, and had found that when the experiment was properly performed there was no deposit of tarry or carbonaceous matter in the tube. If a much longer platinum tube to the Bunsen were employed, and only the lowed part heated so that the gases became cooled again before being burnt, the lamp gave a non-luminous flame, showing that the luminosity was chiefly due to the heating. In reply to a question put by Prof. Foster, he said that when a cold body was introduced into the luminous flame soot was deposited on it.

SINGING FLAME.

THE following experiment, in this connection, has been brought before the notice of the Paris Academy by M. Montenat. Into a long metallic tube, placed vertically, a small metallic basket of live charcoal is let down by a suspending wire. When it has reached the lower part, the current of air produced by elevation of temperature gives rise to a sound which is at first rather weak, but which grows in intensity as the combustion becomes more active. If the charcoal be drawn slowly up, the sounds become at first more intense, then diminish, ceasing quite at the middle. On continuing the movement the sound is renewed, but at a double octave from the first, and it ceases when the fire nears the orifice of the tube. The sound may also be altered by a special arrangement, which allows of altering the length of the tube.

OXIDIZING ACTION OF ANIMAL CHARCOAL.

AT a recent meeting of the Manchester Literary and Philosophical Society, William Thomson, F.R.S.E., said:

I had occasion some time ago to examine a sample of the fluid which had drained from a large heap of several thousands of tons of a mixture of night-soil and animal charcoal, which had lain for about one year or more, covered over with clay and pitch to prevent the rain from washing it away. This heap was about 7 or 8 ft. in height, and the drainage from the whole which could be collected did not amount to more than an average of about 12 gallons in 24 hours. It exuded from the heap in minute streamlets which drained down its sides, and at no part of this immense collection of oxidizing organic matter could the slightest unpleasant odor be detected. The liquid which drained away was mixed with a small amount of suspended matter, which, however, soon settled to the bottom, leaving a perfectly colorless solution which was quite free from smell, but possessed a strong saline taste, and when treated with hydrochloric, sulphuric, or other acid, it produced a copious effervescence.

This liquid was submitted to a very careful analysis.

There are many remarkable points about this drainage water.

First.—Although it comes directly filtering from what originally was most noxious organic matter, it is undoubtedly free from any of those substances, of which albumen may be taken as a type.

Second.—That all these organic matters have been practically completely decomposed by oxidation into carbonic acid, water, and ammonia, and the drainage remains charged with enormous quantities of these products. An idea of the quantity of carbonic dioxide present may be had by saying that 100 c.c. of the water contains 268·54 c.c. of this gas when measured at 0° C. and under a pressure of 760 m.m. of mercury.

Third.—That, although the oxidation of the organic matter had been so complete, yet the water was free from any trace of nitrates or nitrites.

Fourth.—That the water was free from any trace of lime or phosphoric acid, but contained a comparatively large proportion of magnesium carbonate, which was kept in solution by the ammonium salts and free carbonic acid; the presence of this magnesium salt would no doubt account for the absence of phosphoric acid.

Fifth.—The sediment and solution are practically free from bacteria or other animalculæ.

Sixth.—That when the residue from a large proportion of the water is heated to redness it produces no charring or smell.

It might be interesting here to compare a few of the results of this analysis with those from a water which I collected about the same time which drained during a heavy rain from decomposing animal matter, principally butchers' offal, which had not been treated with charcoal. It contained—

Drainage from Animal Matter without Charcoal

	Grains per Gal.
Total solid matter left on evaporating to dryness and heating at 220° F. till it ceased to lose weight	272·335
Matter lost by prolonged heating to redness.	118·475
Saline matter	153·860
Free ammonia	15·447
Chlorine	13·394
Oxygen required by potassium permanganate test	85·629

When the dry residne was heated to redness it emitted a very bad smell at first, and afterwards the smell of burning hair.

Microscopic examination showed abundance of animalculæ swimming about in all directions.

The charcoal with which the night-soil had been mixed deserves some notice. It was that produced in the manufacture of prussiate of potash by the charring of animal refuse, such as hoofs, hair, leather, woolen rags, etc., so that, although it is really "animal charcoal," it differs very much from the substance usually known under that name, viz., that obtained by heating bones to a red heat in closed vessels. It appears to have a powerful effect in absorbing and oxidizing noxious gases, probably greater than any other species of charcoal. I have read an interesting lecture, given by Dr. Stenhouse, of London, many years ago, which was kindly placed in my hands by our worthy President, Mr. Binney. He made some experiments to decide the value of different charcoals, and came to the conclusion that animal, more properly speaking bone charcoal, was best adapted for absorbing color from liquids, but wood charcoal was best adapted for absorbing noxious gases; he, however, draws a distinct line between the capabilities of a charcoal to simply absorb, on the one hand, and to absorb and then oxidize or decompose noxious gases on the other; but he does not mention the results of any experiments made with the charcoal under consideration. The following analysis of this substance was made and given to me by Mr. Spiegel, of Oldham:

	Per cent.
Water	30·510
Organic and volatile matters	4·520 } *
Carbon	22·790 }
Sand and insoluble matter	16·300
Oxide of iron and alumina	12·669
Lime	2·110
Magnesia	0·500
Sulphuric acid	5·330
Potash	3·117
Soda	0·759
Ferrocyanic acid	0·315†
Traces of phosphoric acid, carbonic acid, and loss	1·059
	100·000

ON THE TRANSPORT OF SOLID AND LIQUID PARTICLES IN SEWER GASES.

By E. FRANKLAND, F.R.S.

THE suspension of vast aggregate quantities of solid and liquid particles in our atmosphere is the subject of daily remark. Cloud, fog, and smoke consist of such particles, and I have repeatedly seen at a distance of a few feet abundance of snow crystals floating in the air, when the atmosphere was apparently perfectly clear and cloudless by placing the eye in shadow and then looking into the sunshine.

Professor Tyndall has, I conceive, proved that a very large proportion of the suspended particles in the London atmosphere consists of water and other volatile liquid or solid matter by showing that the heat of boiling water is sufficient to dissipate them. That this is the true explanation of the disappearance of such particles by the application of a moderate degree of heat, and that it is not caused by the rarefied air from the heated body ascending and leaving behind the suspended matter, as suggested by Tyndall, is, I think, conclusively proved by experiments in which I found that suspended particles of sal ammoniac subsided in an atmosphere of hydrogen scarcely twice as fast as in atmospheric air.

Thus an atmosphere fourteen times as rare as that of London (and, as Professor Stokes remarked, possessing only half the viscosity of air), still offers sufficient resistance to the subsidence of minute suspended particles to prevent them from falling more rapidly than one inch per minute. Such particles could not therefore be left behind by an ascending current of the slightly rarefied but more viscous air produced by an increase of temperature to 100° C.

In addition to these aqueous and other volatile particles which disappear by a gentle heat, there are also others which consist partly of organic and partly of mineral matters. But the organic seem greatly to preponderate in the air of towns, because such air becomes apparently perfectly clear after it has been ignited.

The processes of fermentation, putrefaction, and decay afford abundant evidence that zymotic and other living germs are present amongst the organic portion of the suspended matters, whilst many analyses of rain water, made by myself and others, show that the salts of sea water are amongst the mineral constituents floating in the atmosphere.

Of the zymotic matters, those which produce disease in man are obviously of the greatest importance. The outbreak of Asiatic cholera in Southampton in the year 1866, for instance, was traced by the late Professor Parkes, F.R.S., to the dispersion of infected sewage through the air. The sewage became infected by the intestinal discharges from some cholera patients who landed from the Peninsular and Oriental Company's steamship Poonah.

In this case the dispersion was produced by the pumping of the infected sewage and its discharge, in a frothy condition, down an open channel eight or nine feet long. The effluvium disengaged from this seething stream was described as overpowering, and was bitterly complained of by the inhabitants of the adjacent clean and airy houses, amongst whom a virulent epidemic of Asiatic cholera broke out a few days after the sewage received the infected dejections. Nevertheless the discharge of the frothy liquid was kept up day and night for about a fortnight, and 107 persons perished. At length a closed iron pipe was substituted for the open conduit; from that day the number of cholera cases diminished, and within a week of the protection of the conduit the epidemic was virtually over.

In this example a potent cause of the suspension of the zymotic poison in the air was obvious, but in the many alleged instances of the propagation of typhoid fever by sewer gases, the condition of dispersion is not so evident. Does the flow of sewage in a properly constructed sewer produce sufficient agitation to disperse liquid particles through the air space of the sewer? I endeavored to answer this question by violently agitating a solution of lithic chloride in a glass cylinder three inches in diameter and thirty inches high, with a wooden rod, and ascertaining whether the atmosphere at the mouth of the cylinder became impregnated with the liquid, by testing it with the flame of a Bunsen burner; but no trace of lithium could be detected at the mouth of the jar, even after an agitation much in excess of what would ordinarily occur in a sewer.

There is, however, another kind of agitation to which sewage is subject that may produce a very different result—I allude to the development of gases during the processes of fermentation and putrefaction. It is well known that the bursting of minute bubbles of gas at the surface of an effervescing liquid causes the projection of visible liquid particles into the air to the height of several inches. Such visible particles are seen to fall back again immediately into the liquid; but it appeared to me not unlikely that other particles, too minute to be seen, might be simultaneously projected, and by reason of the smallness of their masses in relation to their sectional areas, might continue suspended in the air for a long time. To ascertain the fallacy or truth of this notion I made the following experiment:

A quantity of a strong solution of lithic chloride was placed in a shallow basin and acidulated with hydrochloric acid; fragments of white marble were then added, and a paper tube five inches in diameter and five feet high was placed vertically above the basin. So long as the effervescence continued, abundance of particles of lithium were visible in a Bunsen flame held at the upper end of the tube. A tinplate tube three inches in diameter and twelve feet long was now placed in such a position as to bring one of its open ends over the top of the paper tube.

* Containing nitrogen = ammonia 1·065
† Existing as Prussian blue.

The tin tube was nearly horizontal, but slightly inclined upwards from the paper tube, so as to cause a gentle draught of air to pass through it, when it was slightly heated externally near its lower extremity. A Bunsen flame placed at the end of this tube furthest away from the effervescing liquid, showed that the suspended particles of solution of lithic chloride were not perceptibly less numerous than at the mouth of the paper tube; neither were they much diminished at the further end of the tin tube when the height of the paper tube was increased to nine and a half feet. There can, I think, be little doubt that these particles, which had thus been carried along by a gentle current of air for a distance of twenty-one feet, would be similarly conveyed to very much greater distances.

The following conclusions as to the behavior of flowing sewage may be drawn from these experiments:

1. The moderate agitation of a liquid does not cause the suspension of liquid particles capable of transport by the circumambient air, and therefore the flow of fresh sewage through a properly constructed sewer is not likely to be attended by the suspension of zymotic matters in the air of the sewer.

2. The breaking of minute gas bubbles on the surface of a liquid consequent upon the generation of gas within the body of the liquid is a potent cause of the suspension of transportable liquid particles in the surrounding air, and therefore when, through the stagnation of sewage or constructive defects which allow of the retention of excrementitious matters for several days in the sewer, putrefaction sets in and causes the generation of gases, the suspension of zymotic matters in the air of the sewer is extremely likely to occur.

3. It is therefore of the greatest importance to the health of towns, villages, and even isolated houses, that foul liquids should pass freely and quickly through sewers and drain pipes, so as to secure their discharge from the sewerage system before putrefaction sets in.—*Proc. Royal Society.*

NEW STAINING FLUID.

Dr. Dreschfeld states in the *Journal of Anatomy* that a solution of eosin, of 1 part to 1,000 of water, forms an admirable staining fluid. The sections to be stained, having been immersed in this fluid for one minute to a minute and a half, are put up for a very short time into water slightly acidulated with acetic acid, and can then be mounted in glycerin or in Canada balsam. The advantages claimed for this fluid by the author are these: 1. The time required for perfect staining does not exceed one to one and a half minutes. 2. The solution can be kept without altering, and remains perfectly clear for any length of time. 3. Eosin has the property (probably owing to its fluorescence) of clearing tissues. 4. It differentiates the component parts of a tissue, which renders it particularly applicable to complicated structures, as tumors. Dr. Dreschfeld finds it particularly useful in the examination of nervous tissue. The nuclei, nucleoli, and processes of the ganglion-cells and the axis-cylinder of nerve-fibres, are stained light pink; the areolar tissue takes a much deeper color; the medulla of the nerve-fibres, on the other hand, is not stained at all.

CLEANING DIATOMS WITH GLYCERIN.

The *American Naturalist* says that Mr. James Neil, of Cleveland, uses glycerin as an easy and efficacious means of separating diatom shells from the foreign matter with which they are naturally mixed. He fills a two-ounce graduated measuring glass three-quarters full of glycerin and water mixed in equal parts. The diatoms, after being treated with acid and thoroughly washed, are then shaken up in some pure water and poured gently over the diluted glycerin. If carefully done, the water and diatoms do not at first sink into the glycerin, but gradually the diatoms sink through the water and into the glycerin, preceding the light flocculent matter held in the water. After a few minutes, a pipe introduced closed through the water and into the glycerin will bring up remarkably clean diatoms, which are to be afterwards freed from glycerin by repeated washing and decanting.

MICROSCOPIC EXAMINATION OF HOSPITAL WALLS.

The *Medical Record* says that some interesting facts tending to confirm previous observations by others have recently been communicated to the Société de Biologie, by M. Nepveu, of the Laboratory of La Pitié. A square meter of the wall of a surgery ward having been washed after two years, the liquid pressed from the sponge was examined immediately. It was somewhat dark throughout, and contained micrococcus in very great quantity (fifty to sixty in the field of the microscope), some micro-bacteria, a small number of epithelial cells, a few globules of pus, some red blood-corpuscles, and lastly a few irregular dark masses and ovoid bodies of unknown nature. The experiment was made with all necessary precautions; the sponge employed was new, and carefully washed in water that was newly distilled.

VIOLET LIGHT FOR STUDIOS.

A few weeks ago, referring to M. Scottelari's proposal to secure increased chemical action by glazing photographic studios with violet glass, we pointed out the fallacy upon which we conceived his proposal was based, showing that white glass transmitted all the solar rays, violet as well as others, and that violet glass effected no more. M. Scottelari, referring to our remarks, writes to the *Moniteur de la Photographie* as follows:

"Sir,—In its impression of the 5th January, the *Photographic News* gives an account of an experiment tending to prove that under violet glass photographic printing goes on more slowly. Although the conditions of the experiment alluded to are altogether different to those upon which I have based my system of lighting studios, I have still every reason to believe that the result would have been, even in this case, favorable to violet light, if only the experiment had been made in a more complete fashion. At the same time, I am glad to see that the very impartial author of the articles asks his readers to undertake on their part further experiments on the subject. Here, then, is an experiment which I would recommend; it is of an elementary character, and quite within the reach of all. Let a ray of sunlight penetrate a darkened room, the ray coming in through a tiny slit in the shutter. In the passage of this ray interpose a prism. Upon a screen placed at a certain distance will be perceived the beautiful tints of the rainbow, and if the experimenter will now place against the screen a sheet of sensitized paper or any other sensitive surface, he will soon find out the superiority of the violet rays in respect to its chemical action. I am convinced that the honorable experimenter in England, whose results have been given to the *Photographic News*, will make it a pleasure to repeat this experiment, and to communicate his results. Will you agree, etc., Scottelari."

M. Scottelari states here, correctly enough, what is well known to all students and experimentalists in the science of light. That the violet ray is the most chemically active no one will dispute, and a photograph of the solar spectrum will, of course, readily demonstrate this. But if, instead of decomposing the beam of light by means of a prism, M. Scottelari will receive the entirety of it upon a sensitive surface, he will find the whole will produce as much chemical result as did the violet ray when separated by a prism from the other rays.

The case carefully examined is really a very simple one. A window glazed with white glass transmits the whole of the solar rays which reach it, the violet amongst the rest. A window of the same size glazed with violet glass would transmit one-seventh part of the rays reaching it, and these the violet or active rays; but it would not transmit a single violet ray more than the other window. Hence, unless it be argued that the other rays which are contained in white light are absolutely obstructive, no more actinic power could be transmitted by the second window than by the first. That is the point to be demonstrated in aid of M. Scottelari's position, namely, that the presence of the other elements of white light, besides the violet ray, are not simply inactive chemically, but that they are absolutely obstructive or destructive to the chemical action of the violet ray. Such a theory was, we know, held by some of the old experimentalists, some of whom manifested a tendency to transcendalism in relation to the new science of light; but general experience has simply proved that the non-actinic rays are inactive, or at least inactive upon the sensitive surfaces which have been hitherto discovered.

And in referring to the chemical activity of light it must always be estimated in relation to the sensitive surfaces which science has so far discovered. Hitherto, with the haloid salts of silver and the chromic compounds known in photography, the violet ray is active, and the yellow ray without action; but, according to Draper and others, all the rays probably possess photogenic power on some substances. It is possible that M. Scottelari may have evidence to show that the yellow and other rays, except violet, have an antagonistic influence, and obstruct the action of the violet ray on bromo-iodide of silver. And, if this be so, it can be demonstrated by direct experiment. Such a demonstration would lead to other important results, and suggest a revolution in the dark room, which, being generally illuminated with yellow light, should tend to obliterate the image which had been impressed by violet light when a plate was exposed for the purpose of development.

When M. Scottelari referred to his experience with a studio lighted through violet glass as giving decidedly better and quicker results, we were constrained to believe that he was under some illusion, induced by a mistaken preconception of theoretical considerations; but courtesy demanded acceptation of his facts. When, however, he refers us, for confirmation of his position, to experiments which we and others have tried many years ago, we feel bound to point out the fact that these experiments do not justify his conclusion that the violet rays of a given amount of white light effect more work than the whole of the white light containing those violet rays.—*Photographic News.*

ENAMELLING PHOTOGRAPHIC PRINTS.

Mr. H. Knight gives the following in the *Photographic News:* The following simple method of procedure will be found useful to photographers in a small way, or amateurs who wish to enamel a few at a time, and will give results equal to any. Take of

White wax	10 grains
Ether, methylated	1 ounce.

Cut the wax up fine, put it into a bottle, then add the ether, and shake up until dissolved. It will form a milky solution, but does not require filtering.

Take a clean glass plate, pour a few drops on to the surface, and polish with a chamois leather until quite bright: then coat with ordinary negative collodion, and when set and hard, which it would be in about five minutes, put into a dish of clean water for about a quarter of an hour, or wash under a tap until greasiness has disappeared. (The washing effectually removes the iodizing salts and free iodine in the collodion). It must then be stood up to dry, the lower edge resting upon blotting-paper, or dried by heat. Take of

Gelatine	30 grains
Water	1 ounce.

Put the gelatine into the water, and let it remain for about half an hour, or until swelled, then dissolve by placing it into a dish of hot water, keeping it stirred with a glass rod or spoon; when dissolved, let it remain in the hot water for about five minutes without disturbing it, when a scum will generally rise, which can be taken off by drawing a strip of paper across the surface. It must then be strained through fine muslin into a glass measure previously warmed. Then take the dried collodionized glass, previously warmed over gas or fire, and pour on the gelatine solution about one and a half drachms to a $4\frac{1}{4}$ by $3\frac{1}{4}$ plate, and guide it over the surface with a strip of paper or camel-hair brush, and place upon a level surface until the gelatine is set, which will take about ten minutes. Then take the untrimmed print and the gelatinized glass, and put both into a dish of water, carefully examining both surfaces for air-bubbles, which must be removed; and when the print is well saturated with water put it, face down, upon the gelatinized surface of the glass (both under water, and drawn out together), then place upon a table, put a clean piece of blotting-paper upon the top, and press down with the palm of the hand until the excess of water is removed; it can then be stood up in a dry place to dry, which will take about a day, and when dried it can be removed from the glass by cutting round the edges with a penknife.

CURIOUS EXPLOSION.

A curious case of explosion from the incautious use of a light near a mixture of hydrogen and air occurred recently on board the Vesuvius torpedo-vessel, Eng. It appears that in the forepart of the ship there was a water tank of galvanized iron, which was in such a state that it was condemned. A workman having taken his candle too close to examine the attachments, in order to remove the tank, an explosion of gas, produced by the galvanic action between the zinc and iron, took place, fortunately without doing more damage than rending the side of the tank. The workman may be excused in this case.

A REMARKABLE EXAMPLE OF GOLDSMITHS' WORK.

The correspondent of the London *Times*, writing from Rome, February 10, concerning the discovery of a sepulchre at Palestrina, says: "The tomb was found among those olive grounds and vineyards upon the plain at the foot of the hillside up which Palestrina creeps. It was a rectangular chamber, dug in the earth, at the depth of about two meters from the present surface, and measuring 5·45 meters in length by 3·92 in width at one end, and 3·80 at the other. Its construction was of the primitive character, the walls being lined with slabs of tufa, and although the stones which covered it have been crushed in, the contents were found so placed, and, with the exception of the most perishable portions, in so remarkable a state of relative and perfect preservation as to make it an easy task to form a sufficiently correct picture of what the interior was like when, the survivors having turned aside, the slabs forming the covering were laid down, as they have remained for more than 30 centuries. On the walls was hung a panoply of arms, circular shields of bronze, lances, swords, daggers, and it would seem, also, clubs, the weapons of the deceased. Upon the floor, but further to one side—as indicated by a narrow rectangular cavity of about two meters in length in which the bones were found—stood a sumptuous funeral couch made of wood and bronze, upon which lay the body, no doubt gorgeously attired, for among the dust and bones of the dress and body and the crumbled wood and oxidized bronze of the couch were exquisite golden fibulæ, a massive breastplate or headpiece—opinions differ as to which—of solid gold, and other ornaments of the same material. At the head and feet of the corpse stood bronze tripods with their *lebes*, and by the sides a number of objects, some for funeral use, others of a domestic character, which had either belonged to the deceased or had been placed as tokens of respect and affection around his remains. Among them are silver vases and tazze, beautifully wrought and of various forms and sizes; bronze vessels of large size, bronze vases, and what from the quantity of the remains would appear to have been some exquisite pieces of furniture, richly ornamented with ivory delicately carved in low relief. The tomb, spacious as it was, must have been crowded with the things within it, for the remains almost fill a room of about the same size. Unfortunately, the avidity of the peasants at the sight of the gold was such that they broke the bronze shields and the larger bronze vessels and vases in pulling them aside. The material had become brittle, and would not stand the rough handling. The men, however, had sense enough to preserve the pieces, and, as regards the shields, at least, there is little doubt they can be put together. But among the wreck of these and other things, the majority of the silver vases, 10 or a dozen in all, are uninjured, and the principal portion of the golden ornaments are in so wonderful a state of preservation that they might have left the workman's hands but yesterday. There is a small vase of gold, or perhaps I should say a golden cup, of the form of half an egg, three and a half inches in diameter, with two delicate little handles, so perfect, so polished, and so bright and clean, that it might just have been taken off the dressing table of a dainty lady who owned a perfect maid. The gold ornaments consist of several fibulæ of remarkable beauty, size, and weight, three gold cylinders delicately ornamented, a quantity of wire fringe, buttons formed of thick gold leaf upon a foundation of wood or ivory, a considerable quantity of loose gold leaf, like so much crumpled paper, sufficient to fill a good-sized basin, and the pectoral or headpiece, whichever it may be.

This ornament, I believe I am correct in saying, is one of the most remarkable examples of goldsmiths' work ever found. It must be remembered I am describing an object of solid gold, as bright and fresh, and, with the exception of one corner which has been slightly crushed, as perfect as a sovereign new from the Mint. It is a plate of gold measuring about eight inches by five, and convex to the elevation of about half an inch along its length, like a board that has been slightly warped, and upon this stand in rows, like cavalry drawn up in line, no fewer than 131 miniature statuettes of animals—lions, horses, and chimeræ—as perfect in detail, and as completely modeled, almost, as if they were the size of life. They remind one of those miniature pieces of sculpture described by Pliny. The horses are the most exquisite creatures imaginable, and not only are they correctly modeled in this microscopic size, but they have trappings of delicate Etruscan wire-work so minute as almost to require a magnifying glass to distinguish them. To give as exact an idea as possible of the manner in which these animals are arranged, I must suppose the plate they stand upon to be so placed that the sides correspond with the four principal points of the compass. Projecting from the extreme edges of the two longer sides, facing, say eastward and westward, are, first, 15 birds with human faces—syrens. Between these birds, but placed sufficiently far back to constitute a second row, are 14 lions couchant, with projecting from the center of their backs, and in addition to their own heads, human heads—sphinxes—looking in the opposite direction. These heads, or rather busts, occupy the position where a saddle would be placed. Exactly behind these is a row of 12 lions standing with their tails thrown up in a curl over their backs, and behind these again, in the fourth row, are 12 lions seated on their hind quarters. These four rows of animals, commencing from the one and the other of the longer sides, look, as a matter of course, in opposite directions—*i.e.*, east and west—and are divided by a slightly raised elevation along the central line of the length of the plane, upon which are 9 couchant lions, four facing northward and four southward, while the one in the center, the ninth, is, in fact, a lion's body with a head at each extremity. On the backs of these lions grow heads of goats. It will be observed that while the creatures in the first and second rows along the length are 15 and 14 in number, in the third and fourth rows there are only 12. This leaves a space at each end, which is occupied by 8 horses facing north and 8 facing south, 4 on each side of the elevation along the length. The edges of the narrower sides of the plate are finished by a cylindrical ornament, like a well relieved torsus, covered with Greek pattern minutely executed in microscopic gold beads, and having lions' heads at the extremities. At the back of this plate along the length are two rows of short tubes, of the same form as the long beads called bugles, placed at short distances from each other. Through these it is evident the strings were passed to fasten it on to the dress; but to what part of the dress this remarkable ornament was attached is a matter of conjecture it would be highly interesting to determine.

In perfect keeping with this ornament, and no less remarkable, are two of the gold fibulæ, on one of which are 16 winged sphinxes, and on the other 16 lions with double human heads. These creatures are placed in fours, upon an

arrangement like the runners of a sledge turned up at the ends and separated about three-eighths of an inch from each other. Another of the gold fibulæ is remarkable for its size and massive character; it measures about five inches in length, with a long elastic pin fitting upon an open sheath. The three gold cylindrical ornaments I have mentioned—if ornaments they are—are very curious. They have all the appearance of cases intended to preserve papyri, and who knows but they may have held a record of the deeds of the defunct? They are hollow tubes of about eight inches in length and three-quarters of an inch in diameter, the ends of which were made—as one which has been opened shows—to slip on and off, like those of the circular cases of leather artists sometimes keep their pencils in. They are elaborately and delicately ornamented with what is called the Greek pattern and have lions' heads at the extremities. One of them is fastened upon a flat gold plate, in size corresponding to its length, but a little wider, to give room on one side for 11 figures of lions couchant, five facing in one direction, five in the other, and the central one having two heads. The cylinder that has been opened has inside what appears to be a round stick of smaller size than the diameter upon which the papyri may have been rolled.

It is impossible at present to make any conjecture as to what the infinite quantity of ivory fragments formed parts of. They are sufficient to cover a large table, and fill several trays, and are of all sizes, from particles of dust to irregular pieces of three or four inches in length. The majority are flat, of about a quarter of an inch in thickness, covered with figures of men and animals carved in low relief, and all Egyptian in character. No attempt has yet been made to put the pieces together, but there are many sufficiently well preserved to justify the expectation that at least some important parts of the compositions may be restored. With these ivory fragments are two curious ornaments: they are thin bronze bands of about an inch in width, and bent into semicircular forms, so as to fit, one must suppose, upon the head like a fillet. The ends are formed into delicately twined hooks, like the letter S, with rings hanging to them, and couchant upon each of the fillets are six miniature statuettes of animals—an inch and a half in length as they lie—carved in ivory and richly gilt with thick gold leaf, much of which, however, has come off. There are also a number of other animals of the same size, in different positions, standing, couchant, and seated upon their hind-quarters, which have evidently belonged to the other ornaments of the same kind. Some of those are broken, but many of them are perfect, and all were gilt.

Of the silver vases and tazze, some are quite plain, but several are richly ornamented with figures of men and animals in *repoussé* work with engraved outlines, and all show a combination of the characteristics of Egyptian and Assyrian art. Interesting as a description of the various subjects on these vases might be, I must content myself with a slight sketch of one as an example of the others: The form is that of a globe of about 10 inches in diameter, from which the upper third has been cut away, the diameter being therefore less at the mouth. The figures upon it are divided into four separate horizontal circular bands, but nevertheless they would appear to constitute one continued subject. On the upper band are a number of birds; upon the next below a procession of young warriors on horseback, each carrying two spears. They ride singly, and are each followed by two footmen armed with spears and shields. This procession is continued on the third band, where there are five horsemen with their attendants, followed by a personage standing in a *biga* driven by an *auriga*, and followed by two swordsmen. Upon the fourth band are what, at the first glance, would appear to be a series of subjects, but which, no doubt, together with the procession, are separate incidents of the story represented. There is first a personage of distinction standing in a garden bounded by a tree at each extremity. Over his head there is a heavily laden grapevine—a pergola—and before him a man tilling the ground. Next are two horses drinking at a brook, and advancing toward them a warrior huntsman carrying two spears, and holding upon his shoulder a stick, from which a hare hangs suspended at his back. Behind him are two large horned oxen following each other. These fill about half the circle, and on the remainder the warriors and footmen, seen in the procession, are attacking a number of lions who have fallen upon a herd of large horned cattle. Within these four bands is a circle, or medallion, upon which is represented a man prone upon his face, with a lion standing over him.

Upon one of the tazze, but slightly concave, of about nine inches in diameter, is a curious representation of warriors hunting, or fighting with monkeys of the orang-outang species, if anything, larger than the men. Perhaps, however, the most important among these silver tazze is one—unfortunately broken—upon which, in engraved outlines only, are four representations of the mystic bark of the Sun, placed so as to form a square, and carrying figures of Osiris, Phra, and other Egyptian divinities, while at the angles are groups of Isis and Horus. Around the edge of this tazze runs an inscription in characters not yet deciphered.

A PHOTO-OIL PAINTING process, or mode of coloring photographs, by B. F. Irish, of New Bedford, Mass., consists in first mounting the photograph on glass, face downwards, then grinding it thin from the back, and then treating it with paraffine or its equivalent, for the after reception of oil colors, applied directly to the back of the picture, or to a second glass, to be applied as a backing.

STEEL MAKING BY A NEW PROCESS.

STEEL is so important an element in all engineering operations that any efforts which may be made towards effecting substantial improvements in the method of its production cannot fail to be watched with interest, and a new process which is being brought before the public by the Red Moss Metal Company is certainly worthy of attention. This new process, which is described as "a method of producing pure charcoal steel directly from the ore," is the invention of Mr. Henry Larkin, of Manchester, who has devoted some five years to the perfection of the various details, and these we have had an opportunity of inspecting in the several stages of the manufacture at the works now in operation at Warrington. Before, however, describing the process, we may state that the chief object of the inventor has not been to produce what may be termed a cheap steel, or to compete with either the Bessemer or the Siemens-Martin process on their own ground, but primarily to secure purity and accuracy in the production of a high class tool steel, although at the same time he claims to have effected such economies by his special method of manufacture as to enable the company to compete in the market on the basis of price as well as of quality. The method adopted differs essentially from the ordinary routine of smelting, puddling, rolling, and converting into blister steel, the aim of the inventor being first to secure a pure powdered metal, and then to convert this directly into steel by the agency of pure carbon and uniform treatment, which, as seen in operation at the Warrington works, may be described as follows: The first operation is the crushing of the ore, which we may add is obtained from the Marbella Mines on the coast of Spain, on account of its magnetic properties, an essential although not an absolutely indispensable feature in connection with the process adopted for removing all extraneous and impure materials. The crushing is effected by passing the large and small lumps of the ore first through the jaws of one of Blake's machines, set as closely together at the bottom as practicable, the crushed material being sifted as it falls, and the coarser portion then passes through a disintegrator. In this way the whole bulk of the ore is reduced to the condition of iron sand, mixed, of course, with the gangue of the ore; and the next step is to separate the actual ore from all extraneous matter, for the purpose of obtaining as nearly as possible a pure oxide of iron. This is effected by an ingeniously contrived self-acting magnetic separating machine, specially devised by Mr. Larkin for the purpose. In this machine, which is capable of dealing with large quantities of material, the particles of magnetic oxide are picked up by magnetic attraction contained in a pair of revolving drums studded at intervals with horseshoe magnets, and carried into their proper receptacle, whilst the refuse is deposited in another. Having thus got as pure and rich a material as possible in a powdered condition, the next operation is to mix it thoroughly with a sufficient quantity of powdered carbonaceous matter to combine with the oxygen of the ore, and thus effect its reduction. Powdered charcoal and resin, or other suitable bituminous substance, reckoned together somewhat in excess of the oxygen to be removed, is the carbonaceous matter employed, and the mixture, after being slightly warmed and compressed into blocks in an ordinary brick press, is ready for the reducing furnace. This furnace consists of a series of D shaped gas retorts, with doors to open at each end. The retorts are heated by a fire acting somewhat on the principle of a Siemens' gas producer, and are supported throughout their entire length by an intricate arrangement of brickwork, which also serves to prevent a too ready escape of the hot air into the flue. The burning gases from the fire are also made to completely envelop the retorts by being carried over and under in a zigzag course, thus still further delaying their passage and arresting the heat with which they are charged. At regular intervals air-holes are opened in order to complete the combustion of the gases as they circulate round the retorts, thus securing the greatest heat where it is actually required, and at the same time complete combustion of the fuel used. The retorts being ready for the charge, the door is removed from the feeding end, and a small stack of the pressed bricks of ore and carbonaceous matter, packed closely on a rectangular iron plate, is pushed in by means of an iron rod. The plate being then withdrawn, the stack of bricks is left securely placed, and a second and third feed immediately follow, filling the retort, which is at once closed. After having been exposed to a pretty full red heat for nearly twenty-four hours, gas will have ceased to be given off, the carbonaceous matter will have become practically consumed, and the oxide of iron converted into red-hot iron powder. This having been accomplished, the next important step is to convey the red-hot powder from the retort without exposure to the action of the atmospheric air, and to keep it so until it is cooled. This was an operation at first surrounded with considerable difficulty, but is now accomplished by Mr. Larkin in the following manner: The charge being ready for removal, ordinary coal gas is first, by means of pipes provided for the purpose, turned on into the inside of the discharging end of the retort in order to produce a full outward pressure of gas, whilst the discharging door, which is at the underside of a projecting end-piece of the retort, is removed. The door being thus removed, an iron receiver is brought up closely under the projecting end-piece and securely supported there. By a similar arrangement of pipes gas is now also let into the inside of the feeding end of the retort, when the door of that end is quickly removed and a temporary door with a wide slot halfway down the middle is put in its place. Through the slot in the temporary door the discharging tools are introduced, and the red-hot powder is quickly pushed forward into the receiver placed at the discharging end. As soon as the retort is empty the gas at both ends is turned off, and the iron receiver containing the metallic powder is removed, and kept carefully closed until its contents are cool. When the metallic powder is sufficiently cooled down, and no injury can arise from its exposure, it is turned out of the receiver and again passed through the disintegrator and magnetic machine for final purification. This practically completes the special process patented by Mr. Larkin, the only remaining operation being the mixing with the pure metallic powder thus obtained, whatever additional carbon may be needed, chiefly in the form of resin, which enables the powder to be pressed into cakes, in which form it is passed into the crucibles and is melted in the usual way, with the addition of manganese or any other alloy that may be found advantageous.

At first sight the multiplicity of operations involved in the process would appear to present a serious disadvantage, but they are almost all of them of so simple and automatic a character that they require little more than careful attention and accuracy in weighing and mixing to insure success. And although from the description we have given it will be seen that it is scarcely a correct use of terms to speak of the steel as being made direct from the ore, the whole of the operations are carried on within the works, and can, we are informed, be completed within the space of four days; or, in other words, the company can within that period receive into their works the raw material and manufacture it into steel bars according to the specifications which their customers may require.

The works of the company have been in operation for about two years. Although the production up to the present has been only on a comparatively insignificant scale, the experimental period may be said to have been fairly passed, and the most important feature—the successful application of the process—has now to be considered. The manufactured steel has been subjected to a number of tests, and the results of these furnished us by the company have certainly been of a satisfactory character. Its adaptability for engineering tools has been tested in the workshops of the Great Eastern Railway Company, Eng.; where, in turning cast iron tires, we are informed it has got through at least double the work of any other description of steel which has been tried, whilst still more satisfactory results have been obtained by Messrs. Hobbs, Hart & Co., the lock and safe makers of this city. For ascertaining its toughness and capability of sustaining great tensile strains, a series of tests has been made by Sir Joseph Whitworth, of Manchester, and the following tabulated statement will give the results:

Class.	Pressure first permanent alteration.	Breaking strain per square inch.	Total elongation.	Elongation per cent. showing ductility.
Mild tool Steel	T	T		
A1 No. 1.......	28·86	52·74	·4626	23 13
		Chisel steel		
A1 No. 2.......	31·84	46·77	·4896	24·48
		Chisel steel		
A2 No. 3.......	41·79	69·65	·2236	11·18
A2 No. 4 ...	33·83	59 70	·3185	15·92
Hard tool steel				
B1 No. 5.......	39 80	64 68	·3134	15·67
B2 No. 6	40·80	63·68	·2725	13·62

So far as its success as a commercial undertaking is concerned, the results have not as yet been so satisfactory to the company. Experience has had to be paid for after the usual fashion, and the various processes have only been perfected after costly experiments, whilst the limited quantity of the manufactured article which the company have been able to place on the market has scarcely been sufficient to cover the actual outlay in production. Having now, however, as we have already stated, passed the experimental period, the company feel prepared to compete in the market with best makers of steel, and if they can continue to command the same satisfactory results as those already reported, there is no reason why they should not do so with success.—*Engineer.*

[PETROLEUM REPORTER.]

COMPOSITION OF PETROLEUM, AND THE PROPER STANDARD OF SAFETY.

AT a recent meeting at the School of Mines, Columbia College, Professor Chandler stated that, although petroleum had been known for centuries, it had only recently come into general use for illumination, for the reason that suitable lamps had been wanting. Lamp chimneys were invented about the beginning of the present century, previous to which time there had been only smoky lamps such as are found at Pompeii. The inventor of lamp chimneys had done a great deal for civilization by making it possible to read at night. In 1856, the manufacture of oil from Boghead coal was begun, and in a short time coal oil, or kerosene, had come into extensive use. Lamps had been devised for burning this coal oil, and proved suitable for burning petroleum. A company was organized to collect the petroleum, which was soaked up by blankets from the surface of pools of water. The speaker then described the boring of the first well by Colonel Drake, the subsequent excitement, the quantity of oil produced, and other incidents connected with it. The oil, he said, usually comes from Devonian rocks, which are much older than the carboniferous or coal measures. Petroleum contains about 85 per cent. of carbon to 15 per cent. of hydrogen. It consists of a series of hydrocarbons of the simplest kind, known as the marsh gas or paraffin series, CH_4, C_2H_6, etc., or of the general formula $C_nH_{(2n+2)}$. The oils of Italy do not contain any of the lighter oils, which have already evaporated. In Pennsylvania the rocks are impervious, and evaporation was consequently impossible.

In California, where the oil is more plentiful on the surface, there is but little beneath, as it has all run away or evaporated. There is another series of hydrocarbons called olefines, of the general formula C_nH_{2n}, but these do not occur to any considerable extent in American petroleum. They are distinguished from the paraffin or marsh gas series by the fact that they are attacked by sulphuric acid and converted into alcohol, so that the manufacture of alcohol from illuminating gas is a possibility. Alcohol was exhibited at the Paris Exhibition made in that way. There is some doubt at present whether the white solid which we call paraffin belongs to the paraffin or the olefine series; probably they are some of each series. There is another series of hydrocarbons known as the aromatic series, benzol C_6H_6, etc., which is found in Rangoon tar, but not in our petroleum. When benzol is treated with nitric acid, it is converted into artificial oil of bitter almonds. Dr. Chandler thought he had noticed this odor in treating petroleum with nitric acid. After a digression on artificial alizarine, the speaker described the method of refining petroleum by fractional distillation, the destruction of coloring matter and gummy substances by sulphuric acid, and washing with soda to remove traces of acid. Sludge acid is the name given to the acid after it has been in contact with the oil, and it is from this acid that we derive the foul odors wafted to this city from Long Island City by every easterly breeze. This acid is used in the manufacture of fertilizers. In regard to testing safe and dangerous oil, Dr. Chandler showed some interesting experiments. Some oil was placed in an open tester and gradually heated on a water bath with a thermometer. It was found to flash, or give off combustible vapors, at 110° Fah.; and it burned at 118°, being what is called very safe oil. He then placed some of this same oil in a closed vessel resembling a metal lamp, but provided with a cork instead of the common head or burner, and having electric wires attached. On heating the oil to 85°, and sending a spark through the vapors, an explosion took place which blew out the cork with a loud report, showing that oil, which has been considered safe, gives out explosive vapor at ordinary summer heat.

NEW MEXICO'S VAST COAL FIELDS.

IN our opinion the coal fields of Colfax County, to the north of Las Vegas, are the most valuable and extensive deposits within our territorial limits. After the purchase of the so-called Maxwell Land Grant by English capitalists, a few years ago, the new owners engaged the services of able engineers who, after surveying the grant, reported to have traced seams and veins of coal over a tract of more than one hundred square miles, averaging over six feet in thickness. Over sixty thousand acres of coal! Without taking into account the thousands of hearths which could be supplied with fuel, what a vast trade this would give to a railroad extended south from Colorado! what an immense amount of steam power this would create for the home manufacture in other resources!

A little further to the east, in the same county, we know

of a vein fourteen feet in thickness, some four miles below the Old States Road, on Rabbit Ear Creek.

Mora County has not been so much surveyed, and we cannot, therefore, give exact localities of coal deposits.

Here, in San Miguel County, we have, a few miles above Las Vegas on the Gallinas river, some splendid deposits of coal, sufficient to supply our town with fuel, if anybody wanted to use such; but as long as wood can be bought at twenty-five cents a *burro* load, nobody cares to invest in coal. Below here, on the eastern slope of the Chupaines mountain, we have again coal beds, as well as on the Pecos river, a few miles above Anton Chico.

Before reaching the Rio Grande Valley we come to the anthracite coal beds, in the Old Placer mountains near Santa Fé, in close proximity to gold, silver, and copper mining districts. The New Mexico Mining Company used this class of coal, to a large extent, in their stamp mills, and it is pronounced to be fully equal to the Pennsylvania anthracite, and better than any other of the kind in the Great Southwest. In the same county of Santa Fé, we know of bituminous coal beds on the Tezuque and Galisteo rivers, as well as near Santa Fé creek, in the mountains above the territorial capital.

In the Sandia mountains there is a four and a half feet thick vein of coal, near the little town of Tijeras, not far from Albuquerque, which the engineers of the Atlantic and Pacific Railroad, some years ago, traced for a distance of nearly two miles.

During the late war the volunteer forces stationed at Los Lunas used some splendid coal brought from the Rio Puerco, and the Quartermaster Department at Fort Craig, further south, used to be supplied with coal from a six feet vein near the town of San Pedro.

Below the *Jornada del Muerto*, our southern contemporaries, at various times reported bituminous coal beds near Doña Ana and Mesilla, on either side of the Rio Grande.

West of the Rio Grande we know of coal beds on the Puerco, and around the Navajoe Reservation, indeed as far as Zuñi.

Very few of all the deposits enumerated here are worked to any extent; but as soon as one town after another springs up on the untimbered plains and mesas of New Mexico, fuel will have to be brought them from the mountain districts, especially if we ever are to have a railroad, and all we need here in this Territory to render it "the peer of any of the States and Territories famous for their mineral deposits and coal fields," is the application of capital and machinery and if we go on attracting the attention of enterprising men from the Atlantic as well as the Pacific States, as we have done during the present decade, New Mexico will not much longer remain the unknown and despised region it used to be. Ah! indeed, our star of fortune is daily growing brighter, and the wise men from the far East commence to see its destiny emblazoned in the horizon in visible chirography—New Mexico, the Eldorado of the southwest!—*Las Vegas Gazette.*

EXAMINATION OF VOLCANIC DUST.

Professor Nordenskiöld, in a paper which has been translated by the "Geological Magazine," gives the following account of the dust which was brought down by a snowstorm on the hot-beds of one of the Royal Swedish residences. He states that "some of the dust was collected and examined under the microscope, and found to consist for the greater part of small, translucent (or transparent), angular, uncolored, glass-like particles, which formed elongated filaments, bent sabre-fashion, or sharp-cornered flat bodies, partly plain, partly connected together in the form of Y or T. The filaments are commonly full of cavities, or pierced in the direction of their lengths by hollow canals, whereby they are often light enough to be able to float on water. On being examined in polarized light, most of the grains of dust are found to be isotropic—that is, without action on the polarization plane of the light passing through them. Only exceptionally can there be discovered under the microscope doubly refracting crystalline particles, presumably of augite or felspar, and non-transparent black grains of magnetic iron ore, that may be drawn out with the magnet. No traces of metallic particles could be discovered in the dust by trituration in an agate mortar and washing, nor did chemical reagents show the presence of cobalt or nickel." He gives the following explanation of its origin: "Under the microscope the Haga dust has in many respects a striking likeness to the finest dust from a so-called 'Bologna drop' that has sprung asunder; that is, a drop of glass which has been cooled suddenly, and therefore, from the most inconsiderable cause, for example, a scratch with a file on its surface, falls asunder to a fine powder. Here we have possibly a hint as to the formation of this dust. On the outbreak of the volcano, an immense quantity of superheated steam and strongly compressed gases has violently escaped out of the crater's lava-sea, and brought along with it masses of its glowing contents more or less finely divided. Naturally the particles of lava, which at first are in a molten state, not only solidify suddenly, but are also cooled to a very low temperature in the upper strata of the atmosphere, and thereby obtain the property of the 'Bologna drop,' of springing asunder, with the least concussion or shaking, to a fine dust."

CROTON CHLORAL IN WHOOPING COUGH.

Dr. Wm. Paulson, of Leicestershire, Eng., writes to the London *Lancet*: "I do not know if the administration of croton-chloral in whooping cough has any originality: but, after a somewhat extended trial, I regard it as almost a specific, and should be glad to have the opinion of other medical men as to its results. I have given it in gradually increasing doses, commencing with one grain twice or thrice a day, and almost without exception there has been a very marked reduction, both in the violence and the frequency of the attacks."

THE SAFE ADMINISTRATION OF CHLOROFORM.

During a recent discussion of this subject before the N. Y. Academy of Medicine, Dr. L. A. Sayre objected to the use of ether because of the struggling on the part of the patient as well as the slowness of its action. He had always employed chloroform, had never had any accident attend its use, and believed that safety depended upon administering it in a peculiar manner. His method was to place five drops, at most ten, in some convenient receptacle by means of which *all* atmospheric air could be excluded from the mouth and nose of the patient. If *all* atmospheric air was excluded, such small quantity would quickly and safely produce anæsthesia. If unpleasant symptoms were developed, artificial respiration would keep the patient alive until the effect from such small quantity of chloroform had passed away; whereas when alarming symptoms developed, after the patient had been inhaling the *diluted* gas for some time, it was not easy, and perhaps impossible, to resuscitate him. Used in that manner, a pound of chloroform would last him a year. Dr. Otis said it would last him ten years.

SCHOOL LIFE AND ITS INFLUENCE ON SIGHT.

By George Reuling, M.D.,
Surgeon in charge of the Maryland Eye and Ear Institute, Baltimore.

If we could be taken back to the walks of the Academy, to the age of Socrates and Plato, when instruction was restricted almost entirely to oral communication, we would find almost all learners to have clear vision. The same immunity from painful and weak sight is discoverable in our days among all people who do not use their eyes to any extent for near work, as among the aborigines of this country, the Indians.

Modern usage, however, has changed all this. The vast amount of learning which the progress of industry has called forth, the many fields of science which it has unclosed and rendered fruitful, are too numerous to impress themselves on the mind simply through the channel of verbal instruction. Close application is absolutely necessary nowadays in order to keep pace with the requirements of our civilization. This being the case, it is of the first importance to make this necessity as little baneful in its effects as possible.

The human eye is very delicately constructed, and a continuous strain upon its muscular apparatus is painful, the more so if light is not adequately and well provided, and if the position occupied while studying is improper. But these conditions give rise not only to painful vision but to permanent injury as well.

The human eye is subject to three distinct formations: the normal or emmetropic eye, in which the image is focused upon the retina; the myopic or short-sighted eye, in which it is focused in front of it; and the hypermetropic or oversighted eye, in which it is focused behind it.

The normal eye is spheroidal in shape, and is so constructed that rays of light coming from a distance, that is, parallel rays, come to a focus upon the retina, which is the nervous internal lining membrane of our eyes. This takes place without effort or fatigue. When, however, the shape of the eye is not that of a sphere, but when it is too flat in the direction from before backwards, then parallel rays of light cannot be brought to a focus upon the retina; on account of the shortening of the axis of the eye, this takes place behind it. Such an eye is not normal, but hypermetropic or *oversight.*

Again, if, instead of being spheroidal, the eyeball is too long or egg-shaped, then the axis is lengthened and rays of light which are parallel, that is, come from a distance, are brought to a focus in front of the retina. Such an eye is *myopic* or short-sighted. In neither case, however, can a correct image be found on the retina; neither when the eyeball is too flat nor when it is egg-shaped, and difficulty in seeing, accompanied by pain, is the result in each condition.

Improper illumination and an incorrect posture are, as has been said, productive of bad results; the worst of these is the state of the eye just mentioned, *i.e.*, short sight. It is a fact that this affection is first noticed when children go to school. People often wonder that this should be so, but it can be readily accounted for. As thus: when we look at near objects a change takes place in the interior of the eye, which change is associated with a certain exertion. The eye being an optical instrument is supplied with a lens which increases in convexity according to the proximity of the object. This increased curvature is brought about in the following manner: The anterior surface of the lens gets to be more convex and moves forward, whilst the posterior surface, although it also becomes more convex, does not change its position. The ciliary muscle, or the muscle of the accommodation, as it is also called, contracts and thereby lengthens the fibres of the ligament which subtends the lens, and by this means the change in the curvature of the lens is produced. When we look in the distance this muscle is inactive, since, in the observation of distant objects, the lens requires only its ordinary curvature; to look in the distance, therefore, is not painful under normal circumstances.

But whenever the ciliary muscle is called into requisition, or, in other words, whenever we observe near objects, the fluid within the back part of the eye, owing to this increased muscular action, as well as to the action of the muscles which pull the eyes towards the nose, is under a higher pressure. The membranes of the eye, however, of which there are three, are very fragile; on dissection, the two inner ones are found to be extremely thin. This is even more so in the case of children.

When the child goes to school and first makes use of its eyes, therefore, the following is found to result: The ciliary muscle—or the muscle of the accommodation, as it is also called—being frequently employed, the hydrostatic pressure within the eye is increased; this pressure being continued and the membranes being very impressible, the most yielding portions, *i.e.*, those situated at the furthest depth of the eye, where the nerve of sight enters the ball, yield, and become expanded or bulge out, thereby lengthening the axis of the eye. The *axis of the eye* is a name given to an imaginary straight line drawn from the center of the cornea (the glistening portion covering what is popularly called the "sight" of the eye), to the center of the retina, the internal lining membrane of the eyeball. When this is too long, rays of light which come from a distance cannot be united upon the retina as they ought to be, but come together *in front* of it, and the eye becomes near-sighted.

The pressure, however, is increased, not only when the child uses its eyes for too long a time or under unfavorable circumstances for reading or writing; whenever the eyeball is overfilled with blood the same effect is produced. This surcharge of blood always ensues when the head is bent forward for any length of time; this position, therefore, is also able to produce short sight.

Since it is an established fact that continued observation of near objects, and a position which causes the body to lean forward, are able to render a healthy eye near-sighted and a naturally near-sighted one yet more so, it is very important to pay attention to the school accommodations of children, more especially to the structure of the desks and seats which they are obliged to occupy.

But it is not alone the desks and seats which are of importance to us; the means and manner of lighting the apartment in which the children are congregated ought to be considered as well. The worse the illumination, the closer must the child approach its eyes to the reading or writing matter, that is to say, the more must it incline its head while reading or writing. This position, however, increases the supply of blood within the eye, and thus materially adds to already existing short sight, and not unfrequently calls it forth.

But it may be asked is short sight a disease? Are its effects so pernicious as to necessitate prevention by the employment of all possible means at our command?

The answer to this is decidedly in the affirmative. The tendency of short sight, if not arrested in its progress, is to destroy the eye. The popular belief, that near sighted eyes are the most durable, is in effect most baneful to the community. The reason why the fallacy has taken ground is because short-sighted eyes can see near objects at a time of life when normally constructed eyes must use convex glasses. This necessity, however, is the result simply of natural changes in the ciliary muscle as well as in the firmness of the lens, which is situated within the eye. When we look at objects close by, the muscle of the accommodation, *i.e.*, the ciliary muscle, by exerting pressure, increases the curvature of the lens. Now, as we get old, say from the forty-fifth year upwards, the lens becomes harder, and consequently will not quickly respond to the pressure exerted upon it by the little muscle; but since, in order to see near objects distinctly, a greater lenticular convexity is required by optical laws, and as the lens will no longer respond without effort to the action of the accommodative muscle artificial means are called for in order to remedy this condition; in other words, we must produce an additional convexity of the lens by placing a proper convex glass in front of the eye. Thus it will be seen that the necessity to wear convex glasses after a certain period is but the result of advancing years—merely a physiological condition.

Short sight, on the other hand, is virtually a disease. I have shown how pressure, exerted upon the soft, yielding membranes, may produce this condition; but it may also eventually call forth an atrophy, a degeneration, a thinness and gradual disappearance of a portion of the choroid membrane, situated in the vicinity of where the nerve of sight enters the eye. But not only may this result. After the eyeball has expanded to a certain extent, the membranes become so thinned, and their power of resistance is reduced to such a degree, that the greatest dangers are to be apprehended. A fluid may collect between the two internal lining membranes; they may in consequence become detached, and incurable blindness may result. On account of these considerations, it is necessary carefully to watch each case, and to pay stringent attention to all those surroundings which are calculated to produce or to develop this disease.

My friend, Dr. Cohn, a physician in Breslau, the metropolis of Silesia, having 33 schools, in which, on an average, 10,060 children are instructed, found, upon careful examination of *all* the pupils, that of this number one thousand and four, or *ten per cent. of all the children,* were near-sighted—a fearfully large percentage!

He further found that *no school* was free of short-sighted pupils, and that the number increased, and the degree of the disease grew more intense from the lowest to the highest class in each school.

He showed, moreover, that out of the entire number only 28 had inherited their short sight, that is, the father or the mother of only 28 out of 1,004 children were near-sighted. This small number proves that hereditary causes must be left out of all consideration; and that the increase of the disease, and, in the great majority of cases, its origin, are entirely due to the influence of school life.

How, therefore, ought the seats and the desks to be constructed, and in what manner should the school room be lighted in order to prevent the spread of this evil?

According to experiments made by Dr. Cohn and Dr. Fahrner, and repeated and verified by me, the seat should never be higher than the length of the child's leg, from the knee downward. According to measurement, this is two-sevenths of the height of the entire body.

In the second place, the difference in height between the desk and the seat must always be equal to the distance of the elbow from the latter, the arm hanging loosely down. This distance amounts to one-eighth of their size in the case of boys plus one inch; it amounts to one-seventh of their size in girls.

In the third place, the *horizontal* distance between seat and deskboard ought either to be equal to zero, or, which is preferable, the inner margin of the desk ought to extend about one inch beyond the external margin of the seat. By this means the pupil is enabled to take hold of the book without bending his body forwards and approaching his eyes too closely to the letters.

The deskboard should have a breadth of 18 to 19 inches, three of which occupy a horizontal and 15 to 16 an inclined position; the inclination should be equal to about 2 inches.

The proper distance at which the writing or reading matter is to be from the eyes of children, is from one and a quarter to one and a half feet.

The seat ought to have a width of ten inches at least, and should be supplied with a back high enough to act as a support to the lumbar vertebræ, that is to say, to the loins, *but not higher.*

It is important that the feet of the children touch the floor; for no child, especially when writing, can let its legs dangle in the air for an hour or more. In order to secure a firm foothold it will instinctively bend its leg backward, and will consequently bring its body just as far forwards as it endeavors to place its feet backward in order to reach the floor with its toes; hence a position is assumed which, as has been said, is productive of short sight.

All seats which are too high should therefore be supplied with footboards, the width of which need not be above 6, although 9 inches are preferable, and should be placed below the front margin of the seat in such a manner that even children of the lowest classes can conveniently place their *entire* feet upon them.

In order that children can stand up while reciting and so forth, a contrivance ought to be made by which the deskboard can either be pushed back or turned over.

The desk must be just so high as to let the elbow rest upon it without displacing the shoulder.

The next question which presents itself is, How ought the school room to be lighted?

The windows ought always to be arranged in such a manner that sunlight enters from that side which is not hurtful to the eyes of pupils, while at the same time it illuminates their work sufficiently. Skylights are admirable in this respect, and, in addition, windows situated to the left of the pupils are advisable. They should never be situated on the right; as in that case the hand casts a shadow on the portion of paper which is to be written upon, and consequently necessitates a close approach of the eye, which position, as has been shown, is favorable to the production of short sight. The windows must be of sufficient height and width to give to each pupil his percentage of light.

A room in which 60 to 80 children are to be placed must

be, *at the least*, 14 to 15 feet high; it is no misfortune if it is higher. The windows of such a room should have a height of 9 feet, and a width of 6 or 7 feet.

The width of a street on which a schoolhouse is to be erected and the altitude of the opposite buildings are also to be taken into consideration.

The best color wherewith to paint or to paper the schoolroom is *light gray*.

Respecting artificial illumination, some little may be said. It is necessary that all gas jets be supplied with a cylinder or chimney, in order to keep the flame from flickering, which alternate changes between light and dark may be a not unimportant factor in the production of short sight. Besides chimneys, lamp shades are required, in order to diffuse the light equally and to produce a proper illumination.

It need hardly be stated—as it is clear to every observer—that badly printed books, or such as are set in too small type, are able to produce near-sightedness. It were, in fact, an excellent and much-to-be desired innovation in the system of teaching, if instruction were more especially oral in those years of school life in which short sight, on account of the extreme impressibility of the lining membranes of the eye, is most apt to be produced.

The children should more especially be relieved of all superfluous writing, as it is particularly while thus employed that short sight is developed.

There is another condition of the eyes which merits attention in the discussion of the effect school life exerts upon children, although it is subordinate in its results to the extremely evil consequences which the state of the eye but now considered, is so apt to call forth. This condition is known as *oversight* or hypermetropia. The discussion of this state —which is not a *disease*, but only a congenital *condition*—will be fully treated of in a subsequent paper. For the present, suffice it to say, that it necessitates children to approach their eyes very closely to the matter before them—if it is unconnected by the proper glasses—and thus a condition which is the direct reverse of short sight is confounded therewith, and very disastrous results are induced. In *oversight* the eyeball is naturally too flat; it is smaller and shorter than it ought to be. Distant rays of light (parallel rays) therefore are brought to a focus behind the retina. Such an eye requires a convex glass, which by increasing the convergence of the rays of light brings forward the image which, on account of the shortened axis, is portrayed behind the retina (and is consequently blurred), and causes it to be distinctly pictured on the nervous lining membrane of our eyes. When looking at near objects, the muscles which turn the eyes inward, in the attempt to increase the visual power of the eyes, pull them towards the nose; when we look at distant objects, the rays of light are parallel, and we do not employ this action, provided the eye is normally constructed. If, however, it is too flat, we bring these muscles almost constantly into play—not only for near objects, but also for the observation of those at a distance—and the eyes are gradually brought into that permanent position, and an internal or convergent squint, or what is known as "cross-eye," is produced.

An oversighted eye, therefore, is able to see clearly neither in the distance nor near by; in the effort to see without glasses its muscular apparatus is strained.

If the arm is employed for any length of time it will tire, and persistent use of it will cause pain; for the same reason the ciliary muscle as well as the internal recti being continuously and unduly active, the eye will be under a fatiguing strain, and painful vision, or what is known as *asthenopia*, will result.

In contradistinction to near-sightedness which, as has been shown, is hereditary only in an exceedingly small number of cases, *oversight* is always and under all circumstances congenital.

Dr. Cohn, whose figures have been given above, found that the proportion of oversighted to shortsighted school children was as one to five. This shows that near-sightedness is a much more frequent affection, and that against it more especially ought the attention of intelligent instructors to be directed. But the dangers resulting from neglect of the condition of *oversight* dare not be left out of view either; it is hoped that what has been briefly said of its results will incite teachers to examine closely into the optical conditions of those intrusted to their care.

Space will not permit me to make some remarks concerning the selection of spectacles in both this state of the eyes and in short sight. I hope to be able at some future time to draw the attention of parents and pedagogues to the dangers resulting from an improper choice of both concave and convex glasses. The selection of both, but more especially of the former, should be restricted to competent persons.

It is the object of the present paper to propose means to prevent the most palpable evils consequent upon incorrect school arrangements. In a subsequent essay this very important subject will be more extensively treated, and especial attention directed to the proper employment of both *neutralizing* and *correcting* glasses in short sight and of convex glasses in the condition known as *hypermetropia*, or oversight.

ANALYSIS OF ONE HUNDRED AND NINE CASES OF RHEUMATISM, TREATED WITH SALICYLIC ACID AND SALICINE.

DR. BROWN, late house physician at the Boston city hospital, has furnished a tabulated statement of all the cases that were treated in the hospital with salicylic acid or salicine since Feb. 12, 1876, at which time this method was first inaugurated there. Cases of undoubted chronic character are excepted. The average amount of acid taken to produce relief was 154 grains; the quantity varied from 30 to 210 grains. The average of the time at which relief was effected was 1·46 + days, varying from three hours to four days. The average time to complete cessation of pain was 2·85 + days, varying from twelve hours to fifteen days. The amount required to produce complete relief from pain and mobility of the joints was 531·22 grains to each patient; in each attack was 343·73 grains. The average time during which the acid was taken by each patient was 6·22 days, varying from one day to thirty-one days.

Two cases died, one from pericarditis and one from cerebral complications. Eighteen cases had one relapse, three had two, and one had five while in the hospital. The universal result of the acid, when given in full doses, was to cause a fall of the temperature. On the pulse and respiration the effect was less marked; in fact, the pulse often increased for a time in debilitated subjects. The patients were usually placed upon the treatment by the house physician soon after entrance, ten grains being given hourly while awake. The practice varied from this in some instances. In Dr. Blake's service pills containing three and one half grains each were made with honey or molasses, and in this form the acid was best taken. The number of cases treated with salicine was too small for instituting comparisons. In three cases of acute rheumatism, with moderate severity, from five to fifteen grains were taken hourly; the average time to relief was two and one third days; to complete relief six and one third days; the average amount taken was 346⅔ grains. The average time in hospital was 13¼ days. It is thought that salicine deserves a more extended trial.—*Boston Med. and Surg. Journal.*

MICROSCOPICAL RESEARCHES ON THE HAIR.

PROFESSOR VON EBNER lately sent in to the Vienna Academy a paper on the above subject, on the basis of the anatomical facts. Professor Ebner seeks to elucidate, as far as possible, the mechanical processes of the growth and change of the hair. Especially it is proved that the inner root-sheath is of the utmost importance for the hair formation, and that the same, notwithstanding its being broken through by the hair, continues to grow during the whole hair vegetation, and in the under part of the hair even with greater rapidity than the hair itself. This information leads to important conclusions, of which one may be mentioned, viz., that the doctrines laid down by Götte and Unna are untenable. Respecting the changes of the hair, the writer defends the doctrine of Langer, that the new hairs are formed in the old derma and on the old papilla. The objections to this doctrine are met by the fact which has been up to the present ignored, that the papilla, at the expelling of the hair, most regularly advances in height. The mechanism of this process is circumstantially entered into. During the upward rising the papilla gets smaller, and beneath the same is formed constantly from the outer and middle hair-skinline a filament which is identical with the hair-stem described by Wertheim. On the same papilla is formed the new hair. The papilla by and by gets gradually larger again and advances, whilst the hair-stem disappears.

ON THE MINUTE MEASUREMENTS OF MODERN SCIENCE.

By ALFRED M. MAYER.

Article VI.

On the Application of the Compound Microscope to Measurements of Minute Lengths.

ANY ordinary compound microscope may, at small expense, be converted into a measuring instrument. One way of doing this is to put in the instrument an eye-piece known as *Jackson's Eye-Piece Micrometer.* Another way is to attach a *camera lucida* to the ordinary eye-piece. Fig. 14 may serve to render clear the construction of the Jackson Micrometer, and the manner of using it.

In front of the objective O, Fig. 14, of the microscope A, is placed a scale, E, which is divided into hundredths and thousandths of an inch, or into tenths and hundredths of millimeters. This scale is cut on glass, and being illuminated by light, reflected through it from a mirror placed below it, the objective O forms at M sharp images of the divisions of the scale. At M is the Jackson micrometer. It is formed of a flat piece of glass, mounted in a thin plate of brass. The glass can be moved in the brass plate, to one side or to the other, by means of a screw shown at S. A fine scale is cut

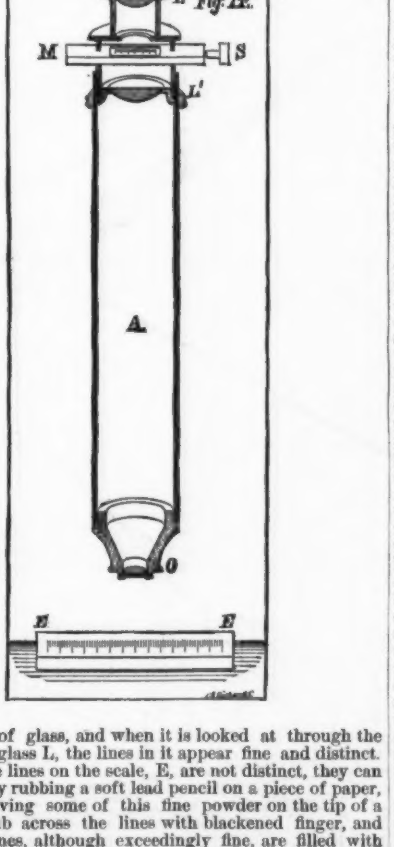


Fig. 14.

on this slip of glass, and when it is looked at through the magnifying glass L, the lines in it appear fine and distinct. If they or the lines on the scale, E, are not distinct, they can be made so by rubbing a soft lead pencil on a piece of paper, and then, having some of this fine powder on the tip of a finger, we rub across the lines with blackened finger, and thus these lines, although exceedingly fine, are filled with the black-lead. The image of the hundredths and thousandths of an inch, on the scale, E, are formed on that surface of the glass slip at M, on which the lines are cut. Thus, the two scales appear as really cut on the same piece of glass. This gives the best possible condition for the accurate comparison of the two scales.

It is evident that the divisions of the scale E will appear larger at M, as the magnifying power of the objective O is greater. Hence the linear value of the divisions of the micrometer will be different for objectives of different powers placed at O. To ascertain the value of a division of the eye-piece micrometer, we have simply to see how many of its divisions are exactly equal to a certain number of hundredths or thousandths of inches of the magnified scale, E. We here give two examples of actual determinations of the values of a division of the micrometer scale when two objectives, a $\frac{1}{4}$th and a $\frac{1}{8}$th, were put on the end of the tube at O. The scale E, when viewed with the $\frac{1}{4}$th objective, was magnified so that four of its hundredths of inches exactly equalled 39 divisions of the micrometer. To find the value of one division, we of course divide $\frac{1}{25}$th of an inch by 39. This gives $\frac{1}{975}$th, or ·001025 of an inch for the linear value of one division. With the $\frac{1}{8}$ objective I found that 30 divisions on the micrometer scale subtend exactly $\frac{1}{100}$th of an inch. Hence one division of the scale, with this objective, equals $\frac{1}{3000}$th of an inch, or in decimals ·000333 inch.

Having ascertained the exact linear value of a division on the micrometer, we can use this scale, on a magnified image at M, exactly as a carpenter uses his measuring rule on his work. Suppose we have a microscopic object, of any form we may imagine, we can readily ascertain the distance across it in any direction by turning the eye-piece around until the scale lies across this direction, and then counting the number of divisions and fraction of a division which include this diameter of the object. The advantages of such a simple micrometer for measuring microscopic objects are very great; for the object on the slide has merely to be brought into any position in the field of view; then we turn the micrometer to coincide with any required diameter of the object; after this we can shift the micrometer scale in the direction of its length so that one of its lines may just touch the edge of the object. Thus measurements may be made with rapidity and accuracy.

Another good method of measuring minute objects with the microscope is that in which we employ the *camera-lucida.*

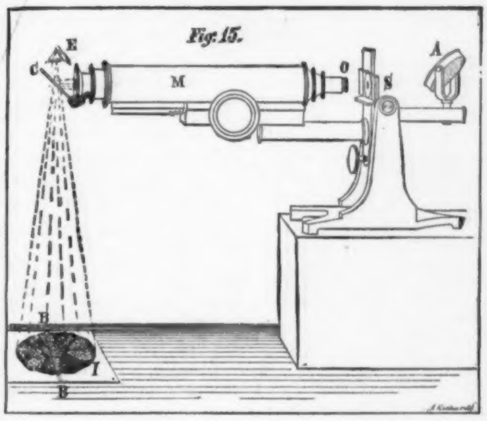


Fig. 15.

The camera-lucida is an optical invention made by Dr. W. H. Wollaston, of England, in the early part of this century. It has received various forms since it was first made by Wollaston. The mode of its action is very simple, and to reduce it to its very simplest and cheapest form we have made one out of a small piece of flat glass, C, which I have stuck on the eye-piece of the microscope, Fig. 15, with a piece of wax.

This inexpensive camera-lucida works very well, especially when we use a kind of glass known as "London fog." A plain spectacle glass of this kind acts admirably. The object of using the tinted glass is that we get from it only the reflection from its upper surface, and thus obtain a sharp definition of the object.

The manner of using this camera is as follows: The glass plate C is placed at an angle of 45° with the center line of the microscope M. The object to be measured is placed on the slide S in front of the objective O. The mirror, A, illuminates this object so that it appears sharp and clear, when the eye at E looks down on the inclined glass C. As the glass C is transparent, it follows that the eye on looking down on it not only sees the object in the microscope but also looks through the inclined glass, and sees the piece of paper, I, on the table below. The vertical distance of this paper from the eye is made ten inches, for this is the distance universally adopted as that of the most distinct vision, and to this visual distance is referred the magnifying powers of all optical instruments. We observe that the eye is directed downwards when it sees the microscopic object, for the rays reflected from the glass plate C go vertically upwards. Now it is a fundamental fact in vision that an object always appears in the direction in which the rays of light, sent out from it, reach the eye, and as with this instrument the rays ultimately reach the eye in a vertical direction, it follows that the object is seen in a vertical direction, and hence it appears as a picture on the paper, below the glass C. Now, as the object appears on the table, it is evident that if the point of a lead pencil is brought on to the paper we will see this point at the same time that we see the picture of the object; therefore, the image of the object, projected on the paper, can be traced by the pencil point. Beginners, who first try this method of drawing microscopic objects, are often much discouraged by their want of success; for, although the image may appear quite distinct, the point of the pencil may be difficult to see, and indeed invisible when placed on certain parts of the picture. This difficulty is owing to the fact that the brilliancy of the illumination of the object is very different from that of the paper, and so the rays entering the eye from the microscope blind it to those coming from the paper and entering the eye through the inclined plate C. By changing the inclination of the mirror, A, the illumination may be so regulated that the pencil point is distinctly visible while we see the image of the microscopic object.

Having executed such a drawing, we can at once have the true dimension of any part of the actual object, by removing the object from before the objective, and placing in its stead a scale divided into hundredths and thousandths of an inch. Then we shall see the scale projected on the drawing, and the divisions of the scale can be traced over the drawing exactly as we previously sketched the object itself. At B, B, of Fig. 15, is seen the drawing of the object, and on it is the drawing of the scale. By taking the dimension of any part of the drawing between the points of dividers, we can find its actual dimension by applying the opening of the dividers to the scale which is drawn over the object.

Unless we wish a permanent record of the object there is no necessity of drawing on the paper anything but the usual projection of the scale. Then we place the object on a slide, S, and move it about before the objective O, until its divisions overlie the part of the object to be measured.

HOW TO BUILD CHEAP BOATS.

By PADDLEFAST.

No IX.

A THIRTY-THREE FOOT SLOOP YACHT.

THE general form of this vessel is shown in Fig. 77. Nautical nomenclature seems to afford no better term in use for this style of build than "skipjack." The principle of construction is to afford a sharp bow with no flat bottom to "pound" in a seaway, and in other respects to approach the lines of a full modeled yacht, and yet to avoid the labor of curving frames and shaping planks. A boat of the form of Fig. 77, when well ballasted, behaves well in pretty rough water, its speed very nearly equals a full modeled boat, and a flat bottom being avoided the leeway is no greater.

The cost can be determined by the builder only; as a guide to an estimate, the following figures are appended: Materials for hull, $100, ironwork bought at chandlery or made to order, galvanized, $50; steering gear—described hereafter—$50; rigging, $50; canvass, 30 cents per yard, 13 in. wide; (topsail and balloon jib are easily dispensed with).

This boat as described is adapted for general cruising; for racing, spars and sails should be larger, the mast and forward end of centreboard shifted a little forward, and the centreboard lengthened behind. For inland and sheltered waters, the build should be broader and shallower, and the sails taller.

The general dimensions are: Length over all, 33 ft.; beam, 13 ft.; depth amidships, 3½ ft; draft at stern, 2 ft. 3 in. Length of spars, mast 20 ft. hoist; boom, 30 ft.; gaff, 14 ft.; topmast, 9 ft.; bowsprit, 10 ft. outboard. Diameters of spars at ⅓ length from butt; mast, 7 in.; boom, 7 in.; gaff, 4 in.; bowsprit, 5 in. Outside length of well, 9 ft., 2 in; centre of mast, 9 ft., 7 in. abaft bow rabbet. Cabin, 12 ft. long. Bowsprit, 5 ft. 6 in. long, inboard. Greatest width of rudder, 2 ft. 1½ in. Sheer, forward, 9 in.; aft, 1 ft. 1½ in. Length of masthead, from upper peak halyard block to throat halyard block, 2 ft.

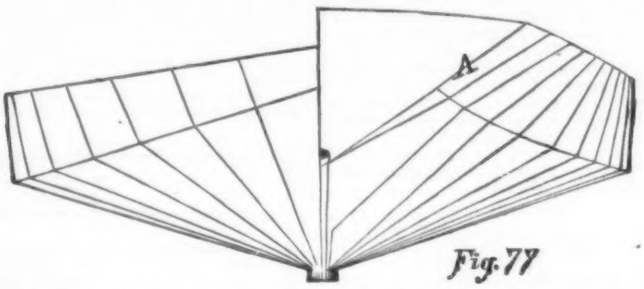


Fig. 77

The topmast shroud spreader is shown by a separate diagram, Fig. 78. The irons A and B on boom, are explained by Fig. 79. The ring B is sprung open a little, slid on to the mast, and then screwed tight. The small rings on ring B, are for belaying pins. The topping lift is belayed to a cleat near A, on boom. The upright piece, F, near bow, is the "samson post," for securing the bowsprit, which is mortised into it. The length of bowsprit inboard should be accommodated to the position of the frames, so as to bolt the samson post against the aft side of a deck beam. The lower end of this post is bolted to the keel. At the upper end, as shown, is the windlass.

That section of the bowsprit over the cutwater is either passed through a vertical iron staple bolted to the aft side of apron, or the upper end of the apron is extended above deck, and the bowsprit let into it. The pump is secured to the aft end of the cabin, near one side, and the nozzle is extended over the combing which surrounds the standing room. Fig. 79 shows the construction of the pump.

The frames, floor timbers, and deck beams are oak, about 2x3 in. The floor timbers are not curved. The keel is 10 in. wide at dead flat, and 3 in. thick. Fig. 80 shows ribs nailed to keel, one about 2 in. forward of the other, and above, nailed to floor beam A, which lies between them. The frames so made are placed about 1 ft. apart. Halfway between these frames, the bottoms, B, are nailed to the keel. To the pieces CC are nailed knees to form the sides of the vessel—shown also in Fig. 82. A 2 in. plank, extended from stem to stern, is nailed to the inside of the knees just under the deck. The deck beams are let into and nailed to this plank. The deck beams are placed as near the knees as convenient, but it has been mentioned that a deck beam should lie just forward of the samson post; it is also desirable to place one at B, Fig. 81, spiking it to the projecting end piece of the trunk. Against the forward side of every whole deck beam, a knee is placed, A, securing it to the 2 in. plank. The short deck pieces opposite cabin and standing room require no such bracing.

A 1 in. pine combing is extended round standing room and cabin room As shown in Fig. 82, this combing is nailed to continuous cleats on bottom timbers and on under side of the short deck pieces. This combing, where it surrounds the cabin, carries a frame, DD, on which the beams of the cabin rest. The deck is narrow 1 in. pine; the cabin deck, ¾ in., covered with canvass and painted. The cabin is usually separated from the cuddy forward; the latter is reached by a hatch, C, Fig. 81. The cabin doors are raised a few inches from the standing room floor, and open outward. Frequent apertures between DD, and the cabin deck above, are the only windows admissible in so low a cabin. A lower opening would admit every sea that washed the deck.

The outside planks are 1 in. thick. The centreboard is 1 in. oak, working in a space of nearly 2 in. The upper sheathing of well is 1¼ in. pine; the lowermost pieces are 3 in. thick, and fastened to keel substantially, as described in SUPPLEMENT 27, page 459. Into these 3 in. pieces are mortised the bottom timbers, CC, and the floor beams rest on the projecting upper edges of the same 3 in. pieces. Close against the well, on the floor beams, run two broad 2 in. pine planks, extending some distance beyond either end of the well.

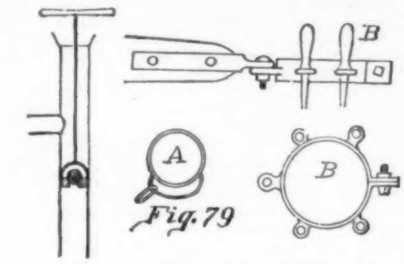


Fig. 79

The ballast is iron, cast to fit between the timbers filling the whole space from the bottom planking to the floor boards above, Fig. 82, and extending laterally to E The surface of the cabin floor is shown 1 ft. 9 in. above upper side of keel. This height allows sufficient ballast for rather light sailing, but the seagoing qualites are improved by raising cabin floor and cabin deck still higher, and using from 2½ to 3 tons of ballast. Some of the ballast must be reserved till the boat is completed and launched, and placed in small pieces in various parts, to trim the vessel. Great care should be observed that all the ballast is tightly and strongly secured, so that it cannot shift or break loose.

In the stern piece, F, Fig. 83, a semi-cylindrical cavity is cut, to receive the rudder post, G. The parts G and H of the rudder are one and the same piece. DD are secured to a knee, E. AA are set in an inclined position—see also A, Fig. 84—and correspond to line A, Fig. 77. Their lower

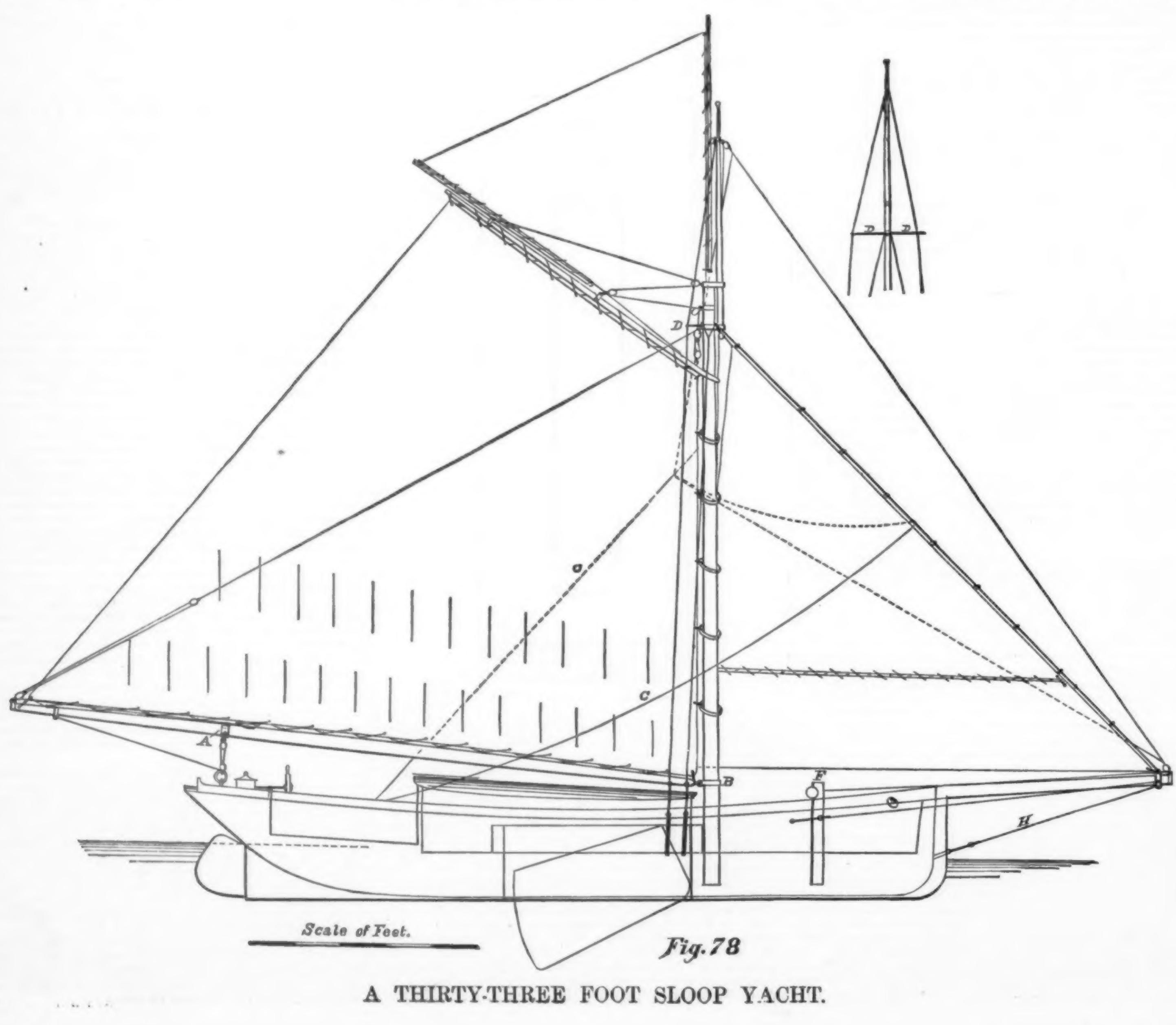
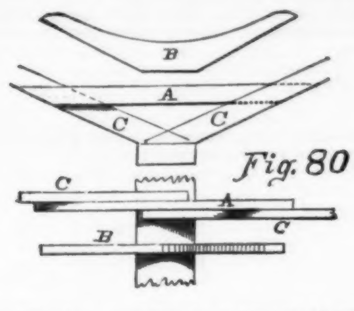


Fig. 78

A THIRTY-THREE FOOT SLOOP YACHT.

ends are concaved to accommodate the rudder post, and nailed to the stern piece, F. A large block, B, also hollowed, is placed above and bolted to F. To block, B, AA can be securely fastened. The upper ends of AA are connected by a deck beam, C. A few additional small pieces may be

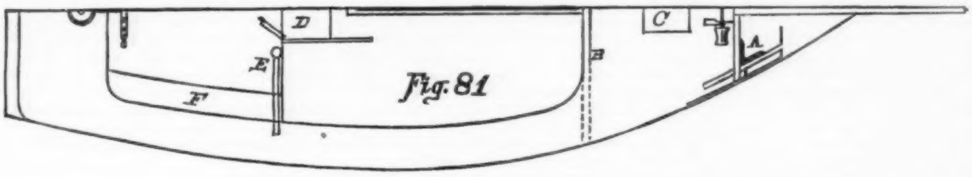


used about the stern according to judgment of builder to bind together the planking, as, for instance, in the position of the dotted line, CB, Fig. 83. The rudder post is lightly boxed in at D, Fig. 84, to prevent the boiling up of the water into the cavity of the stern. A deck beam crosses at I. The cavity in the stern piece is deepened near the top, as indicated by curved line at F, to permit the unshipping of the rudder.

ICE BOATS ON LAND.

To the Editor of the Scientific American:

I HAVE just finished reading the description of the Ice Yacht Whiff in SUPPLEMENT No. 63, and judging it from what little experience I have had this winter, I should consider it a very weak boat. I built a boat last fall from plans given in SUPPLEMENT No. 1, using in its construction spruce instead of white pine, with this addition: I put a ¾ inch rod under the runner-plank, with a block of wood between the rod and plank, directly under the mast, to increase the strength of the plank, for I was a little doubtful of it. I started out one morning with the boat, and, after making several trips across the river, I happened to look at the runner-plank and noticed it was very crooked; but, as the wind was fair for a good sail, I would stay out until something broke. I had made a splendid run up the river, and coming around I started for the shore at the rate of about 45 miles an hour. I had not gone over half a mile when snap went the runner-plank, parting the ¾ inch rod as if it had been a pipe stem. I kept the boat on her course, and after running about 200 yards it stopped, with no further damage. After that mishap I thought it best to try some other wood instead of spruce, so I got a birch plank 4 inches thick and 13 inches wide, and tapered from the side bars to the end to 2½ x 11 inches. Instead of mast-bench, I took two pieces of the same material 2 inches thick and 13 inches wide, and formed a truss from the mast to within 18 inches of the end of the runner-plank, and now I have got something that can be depended upon. I have driven the boat through snow-banks 8 inches deep, that were drifted hard enough to bear my weight. The boating has been very poor here this



winter, and, after waiting some time for good ice, I concluded to try the experiment of boating on the snow-crust. I made some white oak runners 7 inches wide, 2 inches thick, plating the bottom with saw-plate, leaving an opening in the center of the runner for the shoe to project through to keep the boat from making leeway. It worked splendidly. I enjoyed boating when other boats had to lay up. The boating is about used up, at least as far as I am concerned, as the river is open in front of my place, although the ice in other parts of the river still remains firm.

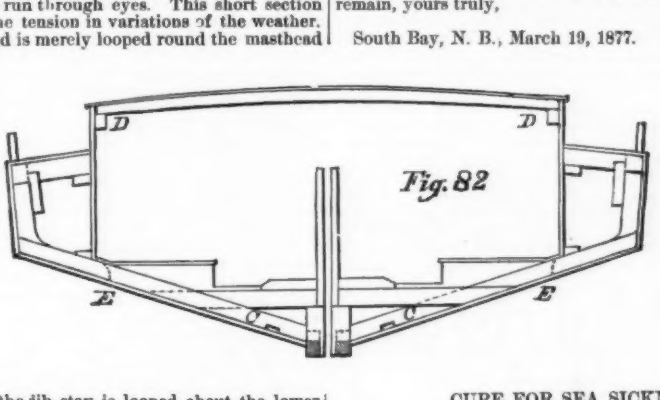
Hoping that I am not intruding on your valuable time, I remain, yours truly,

E. C. SUTTON.

South Bay, N. B., March 19, 1877.

Fig. 84 presents the "Boston steering gear," a popular steering arrangement for small vessels. The bevel wheel on the rudder post should be about 9 in. diameter; that on wheel shaft, about 4½ in. Extreme diameter of wheel, about 2 ft. The external case is a brass cylinder, rigidly fixed to deck.

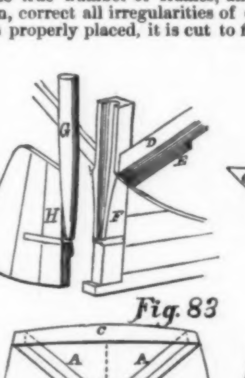
Mainsail and jib are made of No. 9 cotton duck, 27 in. wide, bighted once; that is, doubled in the middle, to increase strength. The halyards are ⅜ in. rope. The shrouds, jib stay, side stays of bowsprit, and bob stay (H, Fig. 78) are ¼ in. wire rope, secured to the various staples on the hull by hemp run through eyes. This short section of hemp equalizes the tension in variations of the weather. The mainmast shroud is merely looped round the masthead

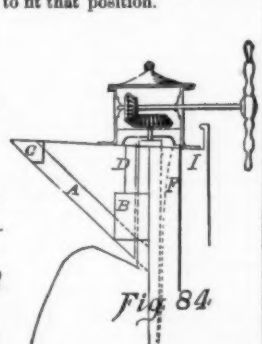


above the spreader; the jib stay is looped about the lower end of topmast, as shown, Fig. 78.

Two anchors are required, one of 50 and the other of 30 lbs.

No working drawing is required. The rough timbers are loosely set up in imitation of Fig. 77, which shows only half the true number of frames, and longitudinal strips, tacked on, correct all irregularities of curve. After every timber is properly placed, it is cut to fit that position.





For the general drawings and suggestion for publication of the foregoing, we are indebted to "Amateur," No. 320 Madison Avenue, New York, who says: "Some years ago, 'Bob Fish' (a yacht sailing master), built a boat on this principle, and sold her to Mr. Livingstone (a member of the N. Y. Y. C.), who fitted her up, and won the annual regatta in her class, the prize being worth more than the boat."

ERRATA.—Correspondents call attention to the following errors in "How to Build Cheap Boats." In SUPPLEMENT 39, Page 608, Table 1, Column 0. Ribs A and 1 should be 7.65, and in SUPPLEMENT 42, Page 670, Table 1, Column 1. Line E, the number 5.13 should be about 8.77.

PADDLEFAST.

CURE FOR SEA SICKNESS.

IN a recent address, delivered before the Liverpool Homœopathic Medico-Chirurgical Society, by T. Skinner, M.D., the president, he stated that lately, while crossing the Atlantic, the only medical event worth noting during the voyage out, was a case of sea sickness in a German gentleman, seven days out from Liverpool. He had constant nausea and headache, worse on raising the head; total anorexia, and vomiting after every attempt to take food. He had also constipation, and a sensation in the left hypochondrium as if his stomach rolled over or round. *Cocculus cm* every two hours relieved the nausea and general symptoms for a time, but as soon as food was taken, he vomited and the other symptoms all returned. I gave him next day, the eighth out from port, and the third from New York, ten drops of *Apomorphia* 3 in half a tumbler of water, one tablespoonful every hour or two. The second dose put him all right, and he sat at every meal, and enjoyed himself during the remainder of the voyage to his heart's content, expressing himself as most grateful for the immediate and permanent relief which the medicine had afforded him.

SCIENCE NOTES.

The Electrical Conductivity of Water.—Many determinations have been made of the electrical conductivity of water. The results differ greatly, Pouillet's value, for instance, being about sixty times as great as that obtained by Magnus. Prof. Kohlrausch has recently turned his attention to the general subject of liquid resistances (*Pogg. Annalen*, Ergänzungsband viii., p. 1), and in the case of water has taken the utmost care that the specimens experimented upon should be absolutely pure, being satisfied that the enormous differences between the results previously obtained were due to impurities. In order to prevent polarization—one of the chief difficulties in determining the resistance of a liquid—Prof. Kohlrausch employed an arrangement by which currents alternately in opposite directions could be passed through the water, a method which was found to be entirely successful. During the measurement of the resistance the water was only in contact with platinum, being contained in a platinum spherical basin, which served as one electrode. The other electrode consisted of a similar spherical platinum surface, which when placed within the first could be made concentric with it. The water was placed between the two and thus formed a portion of a spherical shell. The sample of water which gave the lowest conductivity had been twice distilled, the second time being condensed in a platinum worm, and passed at once into the vessel in which its resistance was to be tested. This sample had a resistance twice as great as that found for water by Magnus, and 120 times as great as that found by Pouillet. Its magnitude may be better appreciated when it is stated that a column of such water one millimeter in length offers a greater resistance than a copper wire of the same section, extending all the way from the earth to the moon and back again. When the water during distillation was condensed in a glass worm, its conductivity was found to be increased more than tenfold, the explanation being no doubt that the water had dissolved some of the alkali out of the glass. Prof. Kohlrausch's paper, quoted above, contains also the results of similar experiments with ether, alcohol, and other badly conducting liquids.

The Compressibility of Atmospheric Air and other Gases when submitted to Low Pressures.—A paper, giving an account of the researches of MM. Mendeleeff and Hemilian in connection with this subject, will be found in the *Annales de Chim. et de Phys.*, sér v., t. ix., p. 111. It had been noticed by one of the authors that when atmospheric air is submitted to a pressure less than one atmosphere, it is less compressible than it ought to be according to Boyle's law—*i.e.*, the product pv, instead of being constant, increases when p increases. Regnault found for high pressures pv to diminish when p increased. The gases operated on were, in addition to atmospheric air, hydrogen, carbonic acid and sulphurous acid, and the experiments appear to have been conducted with minute care, and repeated with different forms of apparatus. The limits of pressure were 650 and 20 millimeters. The compressibility of air exhibits accordingly two changes in sign as the pressure rises from 20 millimeters; it is first compressed more, and afterwards less, than Boyle's law demands. The first change of sign takes place at about 700 millimeters, and the second between 30 and 100 atmospheres, according to the researches of Regnault.

Mr. Crookes' recent Experiments with the Radiometer.—Mr. Crookes has recently communicated to the Royal Society some new experimental results in connection with his radiometer which are of considerable interest. It was a matter of importance to determine to what extent the viscosity of the residual air in the radiometer-bulb influenced the motion of the vanes. This Mr. Crookes has investigated, making accurate measures for air and some other gases, at pressures varying from one atmosphere to a millionth of an atmosphere. The results show that the viscosity of the gas is independent of its attenuation until the pressure is reduced to about 250 millionths of an atmosphere (= 0·19 mm. of mercury), after which it diminishes rapidly as the exhaustion is continued. The repulsion due to radiation was measured at the same time, and was found to increase as the gas was rarefied until the pressure reached fifty millionths of an atmosphere, after which it began to diminish. The repulsion with a hydrogen vacuum was greater than with any other gas. Mr. Crookes in his radiometer researches has hitherto proposed no theory to account for the phenomena observed. He seemed at first disposed to attribute the repulsion of a light disk *in vacuo* to the direct radiant light falling upon it, but he never strongly urged this view, preferring to wait until an accumulation of experimental facts should provide a theory capable of accounting for them all. He has now, however, adopted the view proposed a short time ago by Mr. G. Johnstone Stoney, F.R.S. According to this, the repulsion is due to the internal movements of the molecules of the residual gas; the repulsive force being exerted between the movable vanes and the glass case of the radiometer. The experimental fact that the repulsion in a small bulb is very much greater than in a large bulb—pressure, friction, etc., being the same in the two—strongly bears out this view. Another interesting result is brought out in this paper. Mr. Crookes had previously used plane disks or diamond-shaped vanes. By using curved surfaces like cups, or plane surfaces with one or more corners bent over, he has found that the direction of rotation in the radiometer may be entirely reversed. If the blackened faces of the vanes be only slightly concave, the instrument may be entirely insensible to the action of light or heat. Diminution of the curvature then causes the mill to move in the normal direction *i.e.* with blackened face retreating; its increase, on the other hand, producing motion in the opposite direction.

The Specific Heat of Boron.—In April, 1875, we noticed the results of some experiments of M. F. Weber on the specific heats of certain of the elements, of which boron was one. Boron had hitherto been numbered among the few exceptions to Dulong and Petit's general law of the constancy of the atomic heats of the elements, and M. Weber had explained the cause of the anomaly by the fact that the specific heat of boron rises with the temperature, but at a certain high temperature reaches a value which establishes an agreement with Dulong and Petit's law. In a recent number of Liebig's *Annalen der Chemie*, M. Hampe has shown that the crystals of boron, such as those which M. Weber employed in his experiments, are not pure boron, but compounds of the element. It appears that the black crystals consist of aluminium and boron; the yellow crystals of aluminium, carbon, and boron. All the attempts made by M. Hampe to produce pure crystallised boron had been without success. He is engaged in investigating whether the amorphous boron can be produced in absolute purity. Thus the question as to the validity of Dulong and Petit's law for the pure element boron remains an open one. It is not improbable, however, that had M. Weber used absolutely pure boron, the product of its specific heat and atomic weight would have coincided more closely with the similar product for other elements than was actually found to be the case.

THE EUCALYPTUS.

IT seems that some of the Eucalypti actually overtop the Pyramids in height. A celebrated naturalist, M. Planchon has given in the *Revue des Deux Mondes* a *résumé* of all that is known about these wonderful trees. He says that while the Eucalyptus amygdalina attains to a height of 145 to 152 meters (473 to 496 feet), the dome of the Invalides in Paris is only 105 meters high, the Cathedral at Strasbourg 142 meters, and the Pyramid of Cheops—the highest building in the world—146 meters. The Eucalyptus globulus, although not attaining to the height of the amygdalina, is still taller than the Californian tree, the Wellingtonia gigantea. It is cultivated on a large scale at the Cape of Good Hope, the southern coasts of Spain and France, the Island of Corsica, and especially in Algeria. In Valencia (Spain) the vulgar name for it is the fever tree. A few years ago a Spanish gardener visiting Paris was shown the tree as a novelty. He remarked that it was already a popular specific against fevers amongst the peasants of Valencia and that it had even been found necessary to plant a guard at the fever tree to prevent its leaves from being stripped.

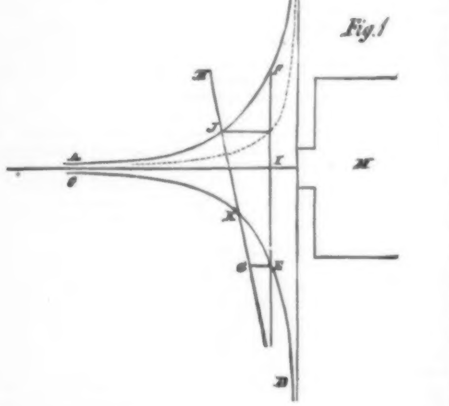
PRACTICAL INFORMATION ON TELEGRAPHY.

In a recent address by Mr. Springer, manager of the Western Union Telegraph, at Chicago, before the Chicago Electrical Society, he said:

"I believe the future of the telegraph is to be even more marked by the rapidity of improvement and extension than has been its past; or at least that the uses of electricity and electro-magnetism will be more varied, and the subject claim more and more the attention of thoughtful minds as time advances. Although we have great advantages arising from our necessary familiarity with electricity in some of its manifestations, those advantages are not fully appreciated, and men from other walks of life are stepping in and reaping the benefits which, but for our want of energy, should fall to us.

"If I could tell you all that will be known of the electro-magnet and its uses in the next fifty years, or even what is now known, and could put it into an attractive form, I could interest you for an hour without speaking of other things. I once made some experiments with an electro-magnet, and, as is usually the case, those experiments and the thoughts they induced taught me many things which I had not known before. I very soon learned that in order to measure the amount of magnetism developed, it was necessary to have a certain mass of metal to be attracted, and that after you had reached that sufficient quantity any addition was useless. Just as in testing the strength of a rope, you must have a proper resistance to tie to, something that will not place the strain unequally upon the several strands, and yet will be sufficient to receive the strain of the whole rope at once. A thin piece of iron, say a sixteenth of an inch, was not sufficient, but after reaching three-sixteenths, or possibly only a quarter of an inch in certain cases, I found that any more would not show any increase of magnetism. If a piece of iron of sufficient thickness were taken, it appeared to make no difference whether the poles of the magnet were covered by the armature or only the edge of it approached them. In either case the magnetism was the same. On observing this, I had hopes that a second piece of iron brought near the poles and placed beside the first would receive an equal amount of attraction, and that if the two should be attached to the same lever thus side by side and insulated from each other, double the effect could be produced. This was an error, and is explained by supposing that the power of the magnet resides in itself rather than in the armature, and that when a magnet has something to attract which is "worthy of its metal" it pulls with all its might, whether that something is in one or a dozen pieces.

We read in books that the attraction of a magnet is inversely proportionate to the square of the distance. This is probably not quite true, because if we take a point at some distance from a magnet, where we have an appreciable amount of attraction, then approach the magnet to within half that distance, we should have four times the attraction we had at the first point; and if we continue to approach the magnet each time by half the remaining distance—which we may do indefinitely—and each time multiply the attraction by four, it is plain that, as the number of divisions are infinite, at least in theory, the magnetism should be also infinite when contact has been reached. This we know to be false, and must prove the falsity of the premises. The proportion is, however, near enough the truth for our purpose."



Suppose we draw a figure bounded partly by a perpendicular line in contact with the poles of a magnet and the double hyperbolic curves A B and C D. If a perpendicular line be drawn cutting this figure at any distance—I—from the poles, the portion E F between the curves will pretty truthfully represent the relative amount of attraction at that point. See Fig. 1.

Taking so much for granted, it is easy to show the error into which operators fall when there is a heavy escape on the wire, and they throw the magnet back much further than usual from the armature. It is plain that the more the magnetism at the receiving apparatus, controlled by the sender's key, the easier it will be to adjust, other things being equally favorable. It requires a certain amount of power to overcome the inertia and friction in the armature, and close the local circuit, else why do we prefer a strong main battery to a weak one. Any less than this is manifestly inoperative. Any additional strength we can gain by placing the magnet close to the armature, without meeting other obstacles, is an advantage. Suppose that the magnet M, Fig. 1, is placed in a line upon which there is defective insulation, causing a leak of three-fourths of the current from the receiving station's battery. Then the sending station may be able to control only about one-fourth of the magnetism in the magnet M. Let that portion be represented by the space between the dotted line and the curve A B—the proportions between quantity and distance holding good in this portion the same as in the whole. Now, if at whatever point the armature is placed, the portion of the magnetism at that point, which is permanent and which the sender cannot control, be balanced by a spring of proper flexibility, then the portion which the sender does control is as available for working purposes as though there was no escape on the line, and the batteries were reduced to one-fourth their present size, and in either case, for the reasons above given, we should place the armature as close to the magnet as possible. This is strictly correct, however, only when we consider the armature inflexible, and the movement so slight as not to affect the conditions of magnetism by change of distance. If, when the sender's key is closed, the magnetism should be sufficient to spring the armature, it might approach so near the magnet as to be held by that part of the magnetism which has been designated as permanent, even after the key were again thrown open, and if the backward movement, when the circuit is opened, be sufficient, the sum of the permanent and controlled magnetism at that point may be less than the permanent magnetism in its position against the forward stop, and therefore not enough to again move it forward. I have found by experience first, and reasoning afterward, that the proper place for the armature is very near the magnet, and that its movement should be as slight as possible, and still admit of breaking the local circuit every time it falls back. I found it necessary in the years 1861–2, when for many months I was compelled to receive Associated Press despatches through a very defective cable—to put these principles to a very severe test. During much of this time I found it necessary to give the armature so little play that it required very close attention to either hear or see it move, and after trying various experiments to facilitate the breaking of the local circuit, adopted the expedient of putting a drop of oil or a morsel of tallow on the platinum points. This proved almost a perfect success. Probably the oil bridged across the space between the points, and while it allowed the current to pass sufficiently to prevent a spark and fusion of the metal which takes place when a perfect break is made, still, on account of its much greater resistance, caused such a reduction of the current as to practically amount to the same thing as a break.

Operators are frequently requested to write firm when sending through repeaters or on a wire where the insulation is poor, and they respond about as frequently by bearing down hard on the key when closing it, or by hammering upon it with almost enough force to break it without paying much attention to the relative length of the intervals in which the circuit is open and closed. What is meant by "firm" writing is that style which will give the most margin for adjustment. A relay magnet is not fully charged in making a short dot, nor fully discharged while the circuit is open for the same length of time. The armature moves with a speed not in proportion to its inertia, but in proportion to the relation between its mass and the power which moves it. That is to say, with a given armature, the greater the power in the magnet when charged, the greater the speed and certainty of its closing the local circuit, and the more perfect its discharge the more certain it will be to open the local circuit. In order, therefore, to have the greatest margin in the adjustment, it is necessary to have the longest time possible for each of the operations of opening and closing, which is accomplished by dividing the time equally between the dots and their spaces. While this is the best possible method of writing, it is not all important, for the reason that shorter dots and longer spaces, if they be regular—that is, the dots of exactly equal length throughout, and the spaces, of like character, also equal to each other—will give almost the same margin for adjustment, though the spring will necessarily be looser in that case than when the spaces are short. If the characters are even and regular an adjustment which will catch one will catch all, but, if uneven, no adjustment can be satisfactory.

A good deal has been said and written about a change of alphabet on account of the "spaced" letters. In reference to this subject I will make two or three remarks. There are no spaced letters in the Morse alphabet as used by the sound operator; or, if there are any, the letter L is the one most entitled to that name, and the so-called "spaced letters" are as easily read as any others when properly formed. Suppose the paper in a register be placed in a perpendicular position in respect to its width, instead of horizontal, and the pen standing horizontally in such a position that, while the lever is playing vertically and the paper moving to the left, the pen may be continually in contact with the paper. Then in

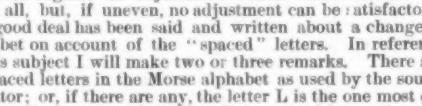


Fig. 2.

writing the word "Louis" the pen would trace the lines represented in Fig. 2. All that the operator who reads by sound has to guide him is the concussions of the lever as it strikes forward or back against the stops, and the intervals of time between them. The longest interval in the alphabet is that between the forward and back strokes of the letter L, and one of the shortest—except those between close characters, as the dots in H or the dashes in M—is that between the first and second dots in the letter R.

In conclusion, let me say to beginners: After you have learned all you can about adjusting and the correct formation of the Morse characters, if you find that it still "stix," don't take a coarse file to remedy it. Platinum is about as valuable as gold, and should not be wasted; besides, an oilstone of something smoother than a file is much better to clean the "points." I might also tell you that when you become the owners of telegraph lines you can make more money by working 300-mile lines, which have but two relays in them, by putting 250 ohms resistance in each relay and reducing your battery about one-half, than you can with relays of 125 ohms and battery sufficient to work them.—*The Operator.*

THE ELECTRICAL SHUNT.

At a recent meeting of the Society of Telegraph Engineers, London, the paper read was on "Shunts and their Applications to Electrometric and Telegraphic Purposes," by Mr. W. H. Preece, one of the Vice-Presidents of the Society. Mr. Preece departed from the usual custom of reading the paper as it had been written, and by delivering, so to speak, a lecture on the subject, he transformed, what from its title seemed to be anything but an inviting theme, into one of the most interesting that have ever been delivered before the Society. The lecture was profusely illustrated by well-executed diagrams, and the experiments were exhibited by means of Mr. Latimer Clark's oxyhydrogen galvanometer specially designed for lecture purposes. We subjoin a *resumé* of Mr. Preece's interesting paper:

ELECTRICAL SHUNTS.

When a current passes by more than one path, that specially intended for its passage is termed the main circuit, while the rest are termed derived circuits.

The effect of introducing derived circuits is to diminish the strength of the current flowing in the main circuit, and when a single derived circuit is applied for this purpose, it receives the technical name of a "shunt."

The law of shunts is as follows: The strength of current in any branch of a system of derived circuits, or "multiple arc," as it is termed, varies inversely as the resistance of that branch. Hence by varying the resistance of the shunt we vary the strength of current flowing through the main circuit.

The resistance of any multiple arc is thus found. Let R be the resistance of the entire arc and r, r_1, r_2, etc., that of each branch respectively. Then since conductivity is the reciprocal of resistance, we may express our problem by the equation—

$$\frac{1}{R}=\frac{1}{r}+\frac{1}{r_1}+\cdots\cdots\cdots\frac{1}{r_n}$$

and in the case of a single main and derived circuit, or "duplicate arc," the equation becomes:

$$\frac{1}{R}=\frac{1}{r}+\frac{1}{r_1}$$

$$\therefore \frac{1}{R}=\frac{r+r_1}{rr_1}$$

$$\therefore R=\frac{rr_1}{r+r_1}$$

That is to say, that the joint resistance of a duplicate arc is equal to the product of the resistances of its branches, divided by their sum.

But by far the most important application of shunts—to electrometric purposes—would be rendered futile were it not that the resistance of the shunt bears a mathematical relation to the current passing in the main circuit, and that by knowing the one the other can be calculated. Thus, in the case of a galvanometer with a variable shunt interposed between its terminals, by observing the deflection of the needle when the shunt is in circuit, we can determine what the deflection would have been without the shunt, by multiplying the reading by a variable factor termed the "multiplying power" of the shunt. This factor is in mathematical language the expression $\frac{G+S}{S}$ where G and S are the resistances of the galvanometer and shunt respectively.

Another fact worthy of notice in connection with this portion of the subject is that by means of a variable shunt the same deflection of the needle of a galvanometer may be reproduced by currents widely differing in strength, and hence all errors due to inequalities in the value of an uncalibrated scale are entirely avoided.

ELECTRO-MAGNETIC INDUCTION.

Any portion of space subject to magnetism was termed by Faraday a "magnetic field." That great discoverer also pointed out in 1851 how the direction and intensity of such a field might be indicated by conceiving the existence of lines of force similar to those traced by iron filings—when allowed to take up any position—in the presence of a magnet. He showed how in like manner the direction of the force at any point would coincide with the direction of these imaginary lines, and that their number in a given area would be proportional to the intensity of the force at that spot.

When a current is commencing to flow through a wire, a magnetic field is projected into the space immediately surrounding that wire; and since we must suppose that its projection is progressive, we must also suppose that at the cessation of the current the field is contracted by progressive stages, although in a space of time too minute to be appreciable. The equipotential lines in this case would form circles, having the wire for their center and in planes at right angles to it, while the intensity of the field depends upon the strength of the current traversing the wire.

Conversely, when either a magnetic field is projected through a wire, or a wire passed through a magnetic field, an electro-motive force is generated in that wire whose amount depends upon the intensity of the field with which it comes into contact. Thus if two wires be placed near each other without touching, and a current be passed through the one, a momentary current will flow in the opposite direction through the other, provided its circuit be closed. This secondary current is due to the projection of the lines of force through the second wire from the first wire at the moment the current commenced. But when the field becomes stationary no current is formed in the secondary circuit, for the conditions under which such currents exist are, that lines of force be cut by a conductor either by their own motion or that of the latter. If, while no current is flowing in the secondary circuit, the wires be caused to approach or recede from each other, then currents are again generated in that circuit whose strength and duration depend respectively on the velocity and time with which these lines of force are cut by the secondary wire. For instance, if we either separate them or allow them to aproach each other rapidly, and only for a short distance, the induced currents will be comparatively strong and of short duration, and the reverse under opposite conditions. Finally, if while all remains at rest the current in the primary circuit—which hitherto we have supposed to be flowing—be suddenly stopped, then a second momentary current flows in the secondary circuit of equal or nearly equal strength but opposite in direction to that formed at the commencement of the current in the secondary circuit. Its presence is due to the contraction of the field through the secondary wire.

INDUCED CURRENTS.

Having made a brief preliminary examination of induced currents and their causes, we are now in a position to study the induced currents in electro-magnets, or "extra" currents, as they are termed. Let us take, for example, an ordinary coil of silk-covered copper wire wound on a bobbin, as usually employed in telegraphic apparatus. If a current from a battery be passed through the coil, and the circuit be suddenly broken at some point, a minute spark will be observed at that point, provided the wire of the coil be of sufficient length. To what is this spark due? In order to answer this question, the coil should be short-circuited or entirely cut out of circuit, when on repeating the operation no spark will be perceived. The spark must therefore be due to something in the coil-wire. If now a core of soft iron be inserted into the center of the bobbin, the size and brilliancy of the spark will be greatly augmented. The phenomenon is, in fact, the result of the induction of the current on itself.

Let us suppose a current entering the coil-wire—say the top layer—then a magnetic field is immediately beneath it. As has already been shown, a current will immediately be formed in these layers flowing in the opposite direction to the battery current through the coil, thereby retarding its progress. After the first effect all remains quiescent, the battery current continuing its flow uninterfered with, but im-

mediately it ceases, the field surrounding the wire immediately contracts, producing a current in the same direction as the battery current, and so prolonging its effects. Hence the spark. The effect of the soft iron core in the center of the bobbin is simply to intensify the field, and consequently the effects.

These currents are met with when cable core is coiled, as in a tank, especially when sheathed with iron wire. They then constitute what is termed "false discharge." Theoretically these currents are formed in straight wires, but to such a small amount as to be inappreciable; and even in theory and disturbances created in such a wire could be traced rather to Static than to Dynamic Induction. Distinct evidences of disturbance due to the latter cause are, however, found in telegraph wires, due to their proximity to the earth. They can be entirely eliminated in rheostats, etc., by double winding—*i. e.*, winding half the wire round a bobbin in one direction and half in the other. Any currents set up are therefore opposed and therefore neutralize each other; but it is impossible to have recourse to such an expedient in electro-magnets, inasmuch as for the same reason we can obtain no magnetic effect.

MAXIMUM AND MINIMUM EFFECTS OF ELECTRO-MAGNETS.

An extended series of experiments was undertaken by the author of the Paper to ascertain the conditions necessary to obtain the maximum and minimum effects in electro-magnets. For this purpose, a Stroh's relay was so arranged that, in its normal condition, it allowed a permanent current to transverse the coil or coils of the electro-magnet under examination; but that immediately a key was depressed, a second battery current traversed the coils of the relay, thereby throwing the lever over against the opposite limiting stop, which action at once broke the circuit of the original current, and placed the magnet in direct circuit with a Thomson's galvanometer, so that any extra currents would be observed upon the latter instrument. The following were the results so obtained:

Regarding the current from a single bobbin and core as the unit, two bobbins and two cores (separate) connected in series gave a current of	17
The two placed end to end so as to form one long core, surrounded by two bobbins connected in series, gave a current of	184
The two cores being connected at the base by a bed or plate of iron, so as to resemble a horse-shoe magnet, the connections remaining the same, gave a current of	304
When connected at the base by a cross-piece and at the extremities by an armature, the connections as above gave a current of	2238

No increase of the length or size of the armature showed any visible variation from the last results.

The general results may be expressed as follows:

The nearer the form of the core approaches to that of a ring or closed curve of iron, and the greater the surface of iron surrounded to given thickness with wire, the greater the strength of the extra current.

If in the last-mentioned experiment the mechanical arrangements remained the same, but the coils were connected "for quantity," the result fell as low as 502. The following were the results obtained with the different relays in general use:

Siemens'	1688
Stroh's ordinary	1621
Stroh's polarized	1500
Thieler's No. 1	279
Thieler's No. 2, the base piece having been removed	26

STATIC AND DYNAMIC INDUCTION.

The effect of Static Induction in the case of telegraph lines is to delay the appearance of a current, and to prolong its duration. Time is required for the charge to dissipate itself, and reduction of the speed of working is the result. We have already shown that Dynamic Induction tends to produce similar effects. So that if the one can be made to counteract the influence of the other, the result of placing electro-magnets in a telegraph line will be a gain instead of a loss in speed.

When an electro-magnet situated on a line of telegraph is shunted by a rheostat or "simple shunt," that rheostat tends to become the path by which the extra currents are discharged, and so prolonged is the magnetization, that if the circuit be closed and opened with any degree of rapidity, the armature sticks or remains permanently attracted—a principle which has been employed by Mr. F. Higgins in double current translation. This retardation is at its maximum when the resistance of the shunt equals that of the electro-magnet. But should the shunt be a second electro-magnet, or, in other words, an "electro-magnetic shunt," then the extra current formed in it opposes that formed in the electro-magnet, and both send a current back into the line. The current from the shunt, however, may be so exalted as to neutralize and even overcome that formed in the electro-magnet itself. So that by a properly arranged electro-magnetic shunt, the magnetic retardation in the electro-magnet itself may be reduced to a minimum, while a current is sent back into the line immediately after each signal, thus tending to increase the speed at which that line can be worked.

Space prevents our taking even a brief glance at the numerous and varied uses of shunts, both to electro-metric and telegraphic purposes, save to mention the fact that so important has become their assistance, that no one who has ever given the matter his full attention can ignore the benefits which accrue from their employment. No delicate tests can be made without their aid, and of such growing importance is the part likely to be played by them in the field of practical telegraphy, that it is well-nigh impossible to over-estimate the benefits which may be derived from their employment.

At the close of the lecture, which, although extending over an hour and a half, had been listened to most attentively by a crowded meeting, a hearty vote of thanks was, on the motion of the President, unanimously accorded to Mr. Preece.—*Telegraphic Journal.*

AN ELECTRICAL CLOCK SETTER.

MESSRS. Barraud and Lund, of Cornhill, are now putting on to the clock of the Banker's Clearing House a very simple electric control. A quadrant of a circle is cut through the figure XII, the center being above the quadrant. Through this project two studs, suspended from the center of the circle by two levers, which ordinarily hang wide apart, one at two minutes to, and one at two minutes past, the hour, both free of the minute hand, but so attached to the armature of an electro-magnet that they fall down sharply when connection is made and meet exactly at XII. They are long enough to engage the minute hand, and will do so every hour by the help of a current from Greenwich—granting that the clock keeps time within two minutes per hour, or forty-eight minutes per day! This will act on the white minute hand, which is permanently fixed five minutes in front of the black minute hand, the bankers being allowed that grace. The control is patented.

ELECTRICAL PHENOMENON AT SEA.

CAPT. HEDDERWICK, of the steamship Victoria, belonging to the Anchor Line, at Glasgow, from New York, reports that on the 18th February, when on the eastern edge of the Grand Banks, a terrific gale from the W. S. W. was encountered, and during the height of the storm there appeared on the trucks, yards, and stays large balls of fire of a phosphorescent nature, strung at intervals of one or two feet, and giving the ship the appearance of being decorated with Chinese lanterns, only the lights were far more brilliant. They settled on the vessel like a shower of meteors, and disappeared almost as suddenly as they appeared—an occasional one dropping from the yards and bursting with a loud report. One of them fell and burst almost in the face of the chief officer, but beyond dazing him for a moment, it caused him no inconvenience.

ROYAL ASTRONOMICAL SOCIETY.

THE January meeting was held at the Society's rooms, Burlington House; William Huggins, Esq., D.C.L., President, in the chair.

Mr. Dunkin drew attention to a paper containing an Ephemeris of the Satellites of Uranus for 1877, and remarked that astronomical observers were greatly indebted to Mr. Marth for the labor he bestowed in calculating these Ephemerides. They occupy but little space when printed, but take considerable time to prepare.

Mr. Dunkin also called attention to an important paper by Mr. Knott, which will probably be printed in the memoirs of the society. It contains a very large number of micrometrical measures of double stars which Mr. Knott has been some years making and preparing for publication. The measures have all been made with an 8-inch achromatic telescope, which was formerly the property of the Rev. W. R. Dawes.

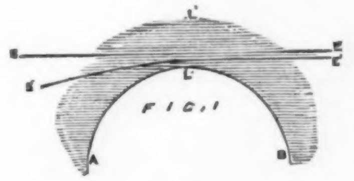


FIG. 1

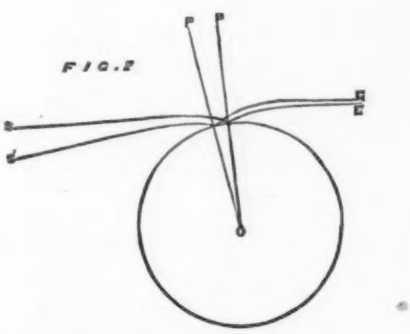


FIG. 2

A paper by Prof. Harkness on the theory of the horizontal photoheliograph was read. The instrument consists of a heliostat and a long-focussed object-glass; the photographs are taken in the primary focus without any distortion, such as that which is met with in photographs taken with the Kew heliograph, an instrument in which the image is enlarged by secondary magnifiers. When the sun's center coincides with the center of the field, the allowance to be made for this distortion is troublesome. But when the center of the sun's image does not coincide with the center of the field, the calculations necessary to deduce the actual distance between any two points upon the sun's disk, from their apparent distance as measured on the distorted photograph, become very complicated. In making use of the horizontal photoheliograph a glass plate ruled with cross lines is placed over the sensitive plate during exposure, so that any shrinkage of the collodion film can be accurately determined, and a plumb-line is suspended so that it can be photographed on the plates, and affords a fiducial line from which the north point and other angles of position may be determined. The paper is one of considerable importance, and will probably be printed in the memoirs.

Mr. Brett read a paper on the bright ring seen round Venus during its passage across the sun's disk. He said, if, in addition to a burnished reflecting surface the existence of which I think I have already proved, we suppose Venus to have a translucent envelop of great density, all the elements for a complete explanation of the mystery of the bright ring seen around Venus when at transit are at hand, or, at all events, it is possible to produce a very similar phenomenon experimentally. A tube in which was suspended the bulb of a thermometer filled with mercury was shown by Mr. Brett upon the table. A beam of light was passed by a collinating lens in parallel rays past the bulb, and the appearance to an eye placed at the further end of the tube was that of a black disk upon which a ring of faint light encroached. Mr. Brett thought that this offered an analogy to the actual condition of the planet, which he assumed must be surrounded by a shell of vitreous matter. At superior conjunction of the planet we should see merely a small circular image of the sun, such as that which had been described by Mr. Christie. In the course of the planet's progress in its orbit, this image would, he thought, become longer and narrower; at greater elongation it would be crescent-shaped, and as the planet approached to superior conjunction, the bright patch of reflected light would, he conceived, extend further and further in latitude upon Venus, till at the time of superior conjunction it would be represented by a ring of light all round the body of the planet. No other assumption would, he believed, account for the bright ring of light around the disk of Venus when on the sun, which was described by many of the observers as brighter than the sun's disk itself. He further wished to suggest that at the next transit of Venus the center of the planet should be carefully observed, in order to discover whether an image of the earth could not be seen upon it reflected from the vitreous surface he had just described.

Mr. Ranyard said that he would endeavor to explain how the bright ring of light, which had undoubtedly been seen by several observers around the body of the planet just before it entered upon the sun's disk, might be explained without making the assumption as to a vitreous envelop which Mr. Brett had suggested. If AB (Fig. 1) be the body of the planet, and SE the course of a ray through the upper part of the planet's atmosphere LL^1, we should expect to find its direction very little altered by refraction, while a ray passing through the atmosphere lower down (S^1E^1) nearer to the planet's surface would be considerably bent. If the refraction of the atmosphere of Venus were equal to that of the earth's atmosphere, a ray passing low down, so as to graze the limb of the planet, would be refracted so as to make an angle of more than a degree with its former course. An observer in the direction E looking at the limb of the planet before it comes into contact with the sun's limb, would, at a certain height in the planet's atmosphere, corresponding to the height where the deviation of the ray is sufficient to bring the sun's nearest limb into view, see a brilliant point of light corresponding to the sun's nearest limb. Lower down in the atmosphere of the planet the deviation of the ray would be greater, and more distant parts of the sun's body would be seen refracted through the planet's atmosphere. Only a few miles below the height where the upper limb of the sun is brought into view by refraction, we should expect to find the density of the planet's atmosphere increasing, so that the lower or more distant limb of the sun would be brought into view. The interval between these two altitudes would, to an observer on the earth, appear brilliantly illuminated with the sun's transmitted rays. In other words, the whole disk of the sun would be seen compressed into a line of light about the further limb of the planet. Without, therefore, making the extraordinary assumption as to the vitreous envelop about the planet assumed by Mr. Brett, it was possible to account for the observed pheeomenon. The course of the ray in the glass envelop of the thermometer bulb could not correspond with the course of the ray in the planet's atmosphere, even supposing the surface ot the planet to give the specular reflection assumed by Mr. Brett—for within the glass envelope of the thermometer bulb the ray would be reflected backwards and forwards from one surface to the other, so as to encroach upon and illuminate the dark hemisphere; but we cannot conceive of such reflection from within the upper surface of the atmosphere of Venus—for the intensity of a reflected ray depends, as is well known, upon the difference of refracted indices of the two media on the either side of the bounding surface from which the reflection takes place, and in this instance the intensity of the reflected ray would be almost *nil.*

Captain Noble said that Mr. Brett's assumption as to the vitreous envelope was of a most artificial character. He could hardly conceive that Mr. Brett seriously asked them to believe that we have in Venus a great thermometer bulb hung up in the heavens.

Mr. Christie said he thought that Mr. Brett's explanation of the ring round Venus was of great importance. At first he had not been able to see how specular reflection would enable one to account for the ring of light round Venus being brighter than the sun itself, but, on looking at the matter a little more closely, he had seen how clearly the assumption enabled all the phenomena to be explained by the ordinary laws of optics. Disregarding the hypothesis about a vitreous atmosphere, which was not essential, though he thought it was quite possible, he would discuss the question as if there were specular reflection from the surface of Venus, and refraction by an atmosphere. A ray from S (Fig. 2), which we will suppose is the north limb of the sun, would be reflected from the surface of the planet, and then refracted so as to enter the eye of an observer at E. A ray from S^1 would be reflected at another part of the planet, and then refracted, so that its ultimate course would be parallel to the ultimate course of the first ray from S. We should thus have light from the whole breadth of the sun gathered into a luminous ring apparently about the edge of the planet, and the light would consequently be very much condensed, and would, therefore, appear to be very much brighter than the light of the sun itself.

Mr. De la Rue asked Mr. Christie how he would account for the bright light seen around the limb of the moon on the sun's disk during a partial eclipse. It certainly could not be supposed that the surface of the moon was smooth enough to give specular reflection, or that there was sufficient atmosphere about the moon to bend the rays after reflection as he had described.

Mr. Christie said that no doubt the two phenomena could be accounted for on the same theory, but he should require a few moments' notice to consider the matter.

Mr. Neison said that there was certainly no specular reflection from the surface of the moon, and he thought, with regard to the passage of the ray past the limb of Venus, it was much simpler to assume, as Mr. Ranyard had done, that there was only a refraction in the atmosphere instead of a reflection and a refraction.

Mr. Ranyard said, with regard to the line of light which had been spoken of as existing round the moon's limb, there can be no doubt as to its presence on the photographs of partial phase eclipses. The line was observed over and over again in 1860; Mr. De la Rue and the Astronomer Royal had both noticed it, and referred it to an effect of contrast. After the 1869 eclipse in America Dr. Curtiss noticed the band of increased brightness along the moon's limb in the partial phase photographs taken at Des Moines, and he had made some interesting experiments upon them, which showed that the band of brightness had an actual existence and was not merely due to contrast. He placed the negatives over a piece of paper on which were dots of various degrees of blackness, and he found that, on moving the negative over the paper, the increased opacity of the collodion at the part corresponding to the bright band was such that dots could not be seen through it which were distinctly visible through the collodion film of other parts of the sun's disk. Such a bright band was to be seen, if carefully looked for on every slightly over-exposed photograph, around every dark object that abutted on every bright field. He thought, however, that possibly, in the case of Venus, the bright band seen around the photographs of the planet when on the sun's disk might be due to the combined effect of the two causes he had referred to.

Captain Abney corroborated Mr. Ranyard as to the photographic origin of the bright band along the moon's disk in

partial phase photographs, and said that it was no doubt due to a circulation on the plate during exposure.

Mr. Wentworth Erck read a note on an improved mode of viewing the sun. His method was to use a small glass prism reflector placed within the image of the sun so that no greater area of light was reflected than would be made use of with the field of view employed. The advantage of this over Mr. Dawes' eyepiece was that the unnecessary heating of diaphragms and eyepieces was thus avoided.

AN OBSERVATORY ON ETNA.

Prof. Tacchini sends us a note read before the Accademia Gioenia on September 22, 1876, entitled "Della convenienza ed utilità di erigere sull' Etna una Stazione Astronomico-Meteorologica," in which, after describing his experiences during a brief ascent on September 15–16, he expresses his views with regard to the establishment and most desirable fitting of an observatory on the mountain to be mainly devoted to spectroscopic and meteorological observations.

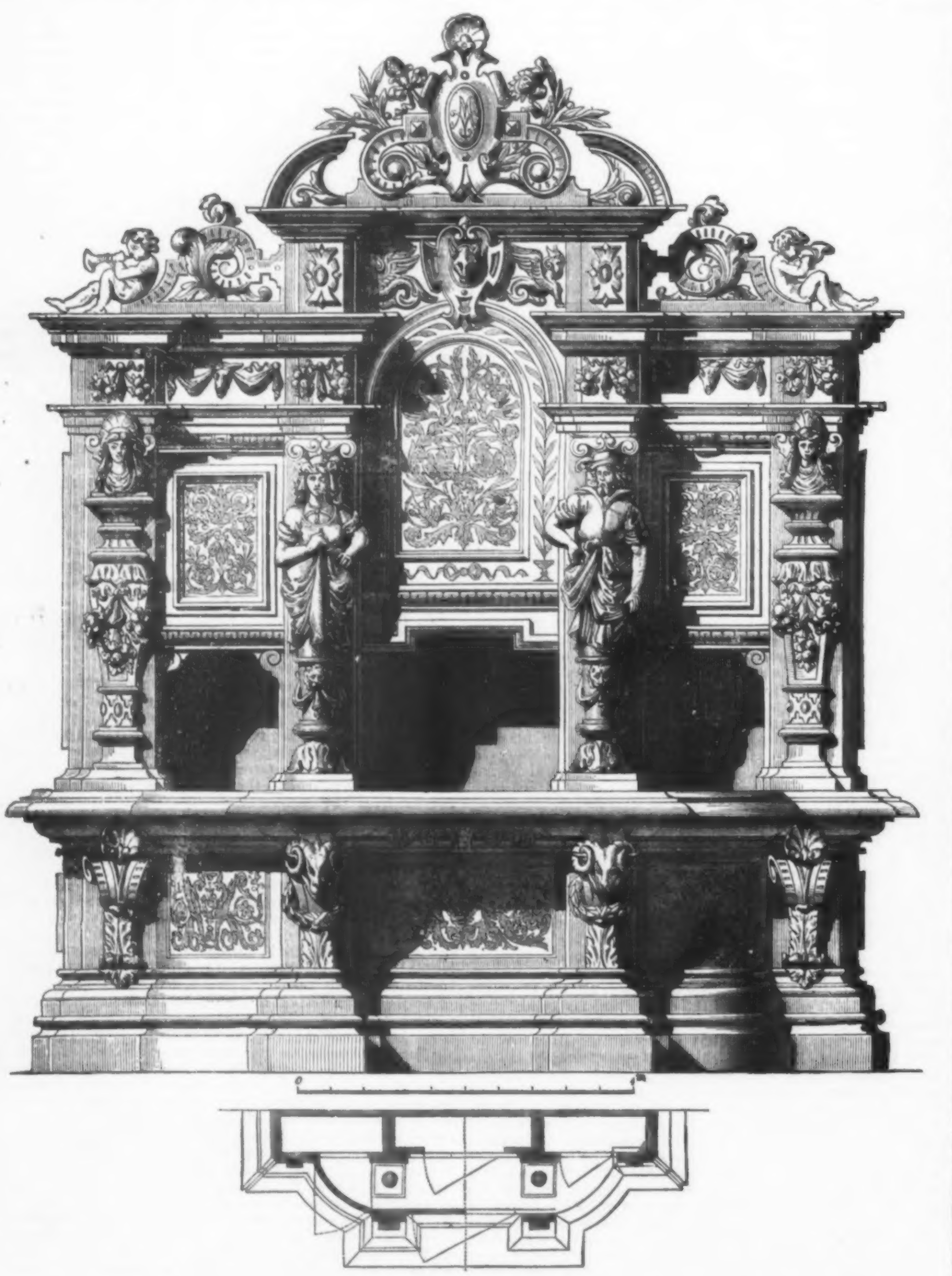
Prof. Tacchini ascended on the morning of September 15 from Catania to the station occupied by a party of the English and American expeditions on the occasion of the total solar eclipse of December, 1870, and found there a diminution of temperature of 33° Centigrade. He had taken with him a Dolland telescope of 3¼ inches aperture, a spectroscope of strong dispersion by Tauber, a small spectroscope of Jannsen, an aneroid barometer, thermometer, and a polariscope. At 10h. 30m. A.M., on the 16th, a few detached clouds only being present, he remarked that the blue of the sky was much deeper than at Palermo or Catania. The solar light had a special character, it seemed whiter and more tranquil, as though due to artifical illumination by magnetism. Viewing the sun rapidly with the naked eye, it was seen as a black disk surrounded by an aureola of limited extent, projected on the blue ground of the sky. On interposing an opaque body before the disk, the aureola was seen better but always limited, and the pure blue sky terminated the same, which extended to rather more than half the solar radius; with the naked eye it was difficult to judge if the aureola was of equal breadth all round the disk, and the only thing well marked was the difference from the view obtained at the level of the sea; while the sky is ordinarily whitish about the sun, on Etna it remained blue, and the aureola acquired a better defined contour. With a helioscope the aureola was much better seen, and its border appeared irregular, and as though it were rather more extended at four points, which, at noon, corresponded to the extremities of the vertical and horizontal diameters of the disk. At 3 P.M., after interruption from clouds which, in passing rapidly at short intervals, produced a striking effect by the formation of a stupendous series of colored rings round the sun containing all the gradations of color in the spectrum, a phenomenon new to Prof. Tacchini, the Tauber spectroscope was applied to the telescope for examination of the solar spectrum, and the observer expresses his surprise at the fine definition of the lines and the extraordinary distinctness of the whole; the chromosphere was bright.

In the evening at 10h., the spectacle of the starlit sky was novel and enchanting. Sirius appeared to rival Venus, the finer constellations acquired an altogether special aspect, and the appearance of the Via Lactea was astounding. The image of the planet Saturn was admirable, and the peculiarities of the ring and belts were seen to much better advantage than at Palermo, shortly before leaving. Venus afforded remarkable proof of the rare quality of the sky of Etna. The planet shown with a wonderful light, which cast shadows during the ascent of the mountain; it scintillated frequently like a star. The telescope showed, on the northern part of the place, an oblong space, less illuminated than the rest of the disk, which Prof. Tacchini says was "sicuramente una macchi del pianeta."

Spectroscopic observations were renewed on the following morning, when the sun had attained an altitude of 10°. The chromosphere was "magnificent;" the invention of the magnesium and of 1474 was immediately evident, which was not seen at Palermo with the same telescope.

With regard to the proposed observatory which Prof. Tacchini is desirous should be an accomplished fact before the meeting of scientific bodies at Rome, in September next, he proposes that it should be erected at the *Casina degl' Inglesi*, and should be named after Bellini, and that it should belong to the University of Catania. He suggests that it ought to be provided with a refractor of first-rate quality and of at least 16 centim. (about 6·3 inches) aperture, and he advises that while the meteorological instruments, which should be adapted to the requirements of the day, as indicated by the London Congress, would remain constantly at the Bellini Observatory, a duplicate mounting might be provided for the refractor at some spot within the University of Catania, with its proper dome, the other being fixed on Etna, so that while from June to the end September astronomical observations could be carried on upon the mountain, during the winter they might be made at Catania, where the sky is a very good one; the astronomer would thus have only the object-glass with its tube to transfer to and fro. Prof. Tacchini further suggests that accommodation for visitors should be provided with the view to increasing their numbers, and that a certain payment should be made by them, to go toward the maintenance of the Observatory and its custodian.

We wish every success to the scheme thus energetically brought before the Italian authorities by Prof. Tacchini, and have no hesitation in predicting important gains to science from its adoption.—*Nature.*



DESIGN FOR CARVED BUFFET BY PH HEUSSLER, WURZBURG.—(*From the Workshop.*)

PRODUCTION OF RAIN BY HUMAN AGENCY.

Ever since it became the impression that the winter of 1876–77 in California was to be what is known as a "dry" one, there has been more or less discussion on the subject of the production of rain by human agency; many persons believing that by exploding large quantities of powder the rain could be made to fall, through some unexplained meteorological conditions. This theory has many firm advocates, and the idea was somewhat strengthened by the fact that a bounteous rainfall occurred immediately after the heavy cannonading which took place during the celebration of the Fourth of July in this city. This confirmed many in the belief, as rain at that season of the year in California was considered very unusual. The subject has been pretty thoroughly discussed in the interior press, and numbers are desirous of trying the experiment. Among these believers in the theory is one who writes a letter from Placer County to the President of the Academy of Sciences, asking the Academy to secure the use of Uncle Sam's guns here to test the theory in the interests of science.

He says, as is generally known, that our last Fourth of July celebration was unusually prolonged for three days, and was followed on the 6th of July by a heavy rain all over the State. Living at Iowa Hill, Placer County, he had good facilities for observing the peculiarities of the storm. "The clouds came rolling up in dark, dense masses, accompanied by a fearful amount of electrical discharge. It seemed to indicate its origin in some unusual, unnatural cause, and the tall pines to-day plainly show the marks of the lightning. The rain fell for one day and night, upwards of two inches falling in that time."

The writer then goes on to say that if this was the result of the firing, as is generally believed, the same effect could, of course, again be produced by the same cause, and suggests an accurate scientific test of the matter.

In commenting on the letter, Prof. Davidson, of the United States Coast Survey, President of the Academy, said that there was a popular belief that after great battles, when heavy artillery was used, a rain storm necessarily followed. This belief rests on no foundation of facts whatever, and comes down to us from almost prehistoric times. It is on a par with the prediction of weather changes at the quarterly changes of the moon's phases, and of the special supplication for rain in particular localities. "Old Probabilities" is gradually sapping and undermining the popular faith in the lunar influence, because the daily predictions of the Signal Service show no relation between the atmospheric storms upon the world's surface and the ever-changing phases of the moon. But the former belief will not be so easily and surely eradicated, because the great battles hardly occur with sufficient frequency to afford the numerical cases demanded to satisfy the illogical mind. Even the actual coincidence can be shown to be not necessarily physical relations of cause and effect.

The belief referred to has not arisen since the invention of gunpowder, but is the tradition of nearly 1,000 generations. Classical readers will recollect that when the Teutones and Ambrones, numbering over 100,000 armed warriors, and as many women and children, left their Germanic homes about 110 B.C., to seek in Italy a milder climate and more productive country, the Roman army, under Caius Marius, crossed the Alps to prevent the invasion. A great battle ensued and 100,000 invaders were slain or captured; and Plutarch, in mentioning the report that the earth was enriched by the dead bodies, says:

"It is an observation, also, that extraordinary rains pretty generally fall after great battles; whether it be that some divine power thus washes and cleanses the polluted earth with showers from above, or that moist and heavy evaporations steaming forth from the blood and corruption thicken the air, which naturally is the subject of alteration from the smallest causes."

But from the contest there was no immediate storm of rain, and he especially refers to the subsequent winter's rains. Nor was there rain after the equally great battle fought in the following August by the Romans, under Caius Marius and Catullus, against the Cimbri, who had crossed the Alps and were overwhelmed. The peculiar difference in the ancient and modern belief will be at once noticed as residing in the causes which produce the rain. Then there was no gunpowder, but suggestions of a divine power or a moist exhalation; now the divine power is overlooked and villainous saltpeter conjured up.

As far as the instance of the Fourth of July firing here was concerned, it is much more probable that natural causes produced the subsequent rain than the burning of powder. The weather, for some time before, had been very hot, and, in a measure, rather peculiar for this climate. Professor Davidson was at that time on Mount Diablo with the Coast Survey party, and kept a record of the thermometer, etc. In the morning of the 1st of July the thermometer was at 86°, at 2 P.M., 101°; on the second, at same time, 84° and 103°; on the 3d, 86° and 101°; on the 4th, 88° and 101°; on the 5th, 86° and 101°; and on the 6th, 64° and 78°, and 7th, 57° and 64°.

Dr. Henry Gibbons, Sr., who has kept a more complete meteorological record for over 25 years in this city than almost any one else, says that there is generally a tendency to rain about July 4th. The rains in California seem to have a very peculiarly marked periodicity. The most marked is probably that which occurs on or about the 20th of May each year. The meteorological conditions on the Fourth of July were favorable to a rain. The tendency to rain showed itself before the firing took place at all. It followed very hot weather all over the State. The atmosphere was not only very hot but very moist. For the first time in the history of the State sunstroke cases were recorded, especially in the San Joaquin valley. The only explanation was the very hygrometrical condition of the air. A tendency to cloud was the natural result of this accumulation of moisture, which resulted in rain. The very hot weather seemed gradually to advance eastward, where, it will be recollected, it was unusually hot. The heated wave crossed the Atlantic to Europe, where it was severely felt. According to all this, therefore, it seems our rain in July was due to natural causes, and not the agency of man.—*Mining and Scientific Press.*

The production of pottery, terra cotta, etc., with surfaces that closely resemble Malachite and other valuable stones, has been successfully accomplished by Charles Brock, Devon, England.